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The Journal of Heredity

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The Journal of Heredity is published monthly by the American Breeders' Association (henceforth to be called the American Genetic Association) for the benefit of its members. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Price of single copies, 25 cents.

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PIGMY HIPPOPOTAMUS OF LIBERIA.

The animal, when full grown, weighs less than 500 pounds, and stands only 30 inches high at the shoulder. He is, therefore, easily restrained by fences, and would not offer the problem of control, if domesticated, that would be furnished by the larger hippopotami, which would scorn any ordinary barrier., As the meat is good, it is believed that this pigmy hippopotamus, in the swamps of the gulf states, might furnish a large quantity of meat with very slight cost of production. (Frontispiece.)

[See "Meat Production in Swamps," page 34.]

HOW TO IMPROVE THE RACE

Success Possible, but not by Processes Employed with Lower Animals—Little Gain from Preventing Marriage of Undesirables — Important Point Is Formation of a Prepotent, Desirable Stock by Marriages of Desirable People with Each Other — This Prepotent Stock Will Then Raise the Level of the Great Bulk of Normals.

Alexander Graham Bell, *Washington, D. C.*

LIVING organisms have proven so plastic in the hands of scientific breeders that we have learned to improve our breeds of plants and animals by suitable selection controlled by man.

Human beings, also, are undoubtedly capable of modification by selection; but it is manifestly impossible to apply to them the processes employed with the lower animals.

The difficulties of the problem may perhaps be appreciated if we consider for a moment how far it would be possible to improve our breeds of domestic animals under the conditions which prevail among human beings.

Given, for example, a flock of sheep to be improved, but under human conditions.

First, we must not butcher any of the animals. Ovine life is to be considered as sacred as human life. We must not mutilate the animals; nor do anything to them that is inconsistent with the humanitarian spirit of the age.

The weaklings are to be preserved and given special care. In fact, all of the animals, including the poor little deformed lambs, are to be kept alive as long as possible. They are to be treated with kindness and consideration until they die of old age, or from other causes beyond our control.

To these condit ons we may add the following: polygamous unions must not be permitted; nor unions between individuals related in various ways.

A man, for example, may not marry his grandmother; nor his mother; nor his sister; nor his daughter; and if we apply all the human restrictions to sheep, we shall have our hands full indeed in merely examining the ancestry of the flock, and the relationships of the individuals to one another, so as to avoid the prohibited unions.

While we are forbidden to allow certain classes of unions, we are not permitted to select the individuals that should be mated together to improve the stock. Each individual of the flock, under the restrictions referred to, must be free to choose its own mate; and the pairing shall be for life.

We may confidently assert that under such conditions no scientific breeder would undertake to improve the flock,—it would not be possible.

THE HUMAN PROBLEM.

But these are the conditions we must face in attempting to improve our own race; and we may as well recognize, first as last, that we have no power to compel improvement.

A gleam of hope, however, appears in this connection when we realize that there is one great and fundamental difference between a community of human beings, and a flock or herd of animals: The individuals of the human community possess intelligence.

The individuals have power to improve the race, but not the knowledge of what to do. We students of genetics possess the knowledge but not the power; and the great hope lies in the dissemination of our knowledge among the people at large.

Another important difference between human beings and the lower animals, arising from intelligence, is that human beings give some thought

to their unborn progeny. All desire that their offspring may be of the best; and no one wishes to have degenerate or defective children.

The attitude of the public mind is therefore favorable to voluntary compliance with plans which appeal to the intelligence of the community as reasonable and right; and favorable to the formation of a public opinion which will compel compliance.

These are such hopeful conditions that they will bear recapitulation.

The members of a human community, both individually and collectively, desire that their descendants may, if possible, be better than themselves.

They possess intelligence to understand the laws of heredity as applicable to man; and a willingness to adopt any reasonable and practicable measures that may be formulated for the benefit of future generations.

All recognize the fact that the laws of heredity which apply to animals also apply to man; and that therefore the breeder of animals is fitted to guide public opinion on questions relating to human heredity. Without power to control, he has power to advise; and the public generally will accept his statements as sound, because based upon special knowledge and experience in the breeding of animals.

What an opportunity for the members of the American Genetic Association to benefit the human race! Most of the disputed questions of human heredity can be settled by them, and their verdict will be acquiesced in by the general public.

Statistics relating to the effect of inbreeding among animals, for example, could surely be made to guide public opinion rightly on the subject of consanguineous marriages among human beings.

So, too, statistics relating to the effect upon the offspring of maturity and immaturity in the parents of animals, would seem to have a bearing upon the question of early *versus* late marriages among human beings.

The first thing for us to do, is to make known to the public the processes that are needed to improve the race; and then to show how, by intelligent cooperation among the members of the community, these processes may be applied.

IMPROVING RACIAL STATURE.

In considering the question of improvement, it may be well to begin by taking some specific quality of an inheritable nature and examining its distribution among the population at large.

Take stature as an example. We have pigmy races of men, and it is quite conceivable that some such race might deem it desirable to increase the general height of the population.

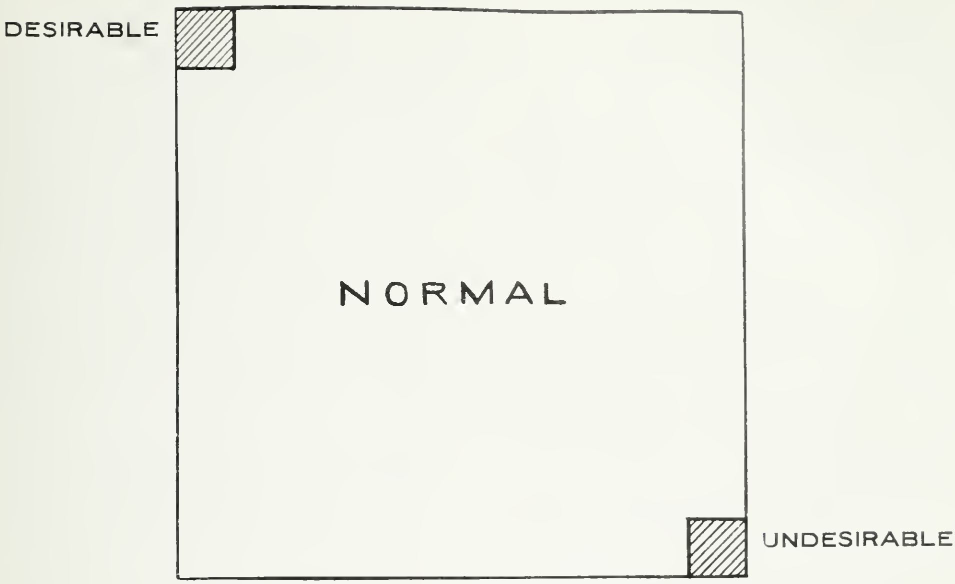
The members of the race all possess the desirable characteristic (height), but in varying degrees; and upon this variability depends the possibility of improvement. The difference between the extremes shows the amplitude of the variation; and if we sort out the population in accordance with the degree in which they possess the quality, we shall find a continuous series from the lowest to the highest. Some intermediate point represents the average degree in which the quality is possessed by the race.

The people who are markedly above the average height will, in this case, constitute the desirable class; and those who are markedly under the average would be the undesirable.

We are accustomed to focus our attention so exclusively upon the desirable and undesirable classes that we are apt to forget that there is an intermediate class, the normal, which is many times greater than both of the others put together, constituting, indeed, the bulk of the population.

The accompanying diagram may perhaps be of assistance in realizing the relative proportions of these classes. Let the large square represent an enclosure completely filled with the people under consideration. The square then represents by its area the whole population to be improved in height.

Now if we look the people over, we shall find here and there exceptional individuals who stand well above the general level. Collect them together



THE MAKE-UP OF THE HUMAN RACE.

In discussions of eugenics, the relatively small part of the population made up by the superior and the inferior is sometimes allowed to occupy so prominent a place that we forget that the great bulk of the race is made up of normal people, as the diagram clearly shows. Mr. Bell points out that because of this overwhelming numerical preponderance of the normal people, the easiest, quickest and most natural method of raising the level of the whole race is to raise the level of this huge mass of normals, instead of devoting all our attention to reducing the relatively insignificant number of inferiors.

into a pen in one corner of the enclosure. These constitute the desirable class represented by the small shaded square at the top of the diagram, which expresses, by its area, the number of tall people found.

In a similar manner, collect the markedly undersized individuals, and place them in a separate pen represented by the shaded square in the lower corner of the diagram. These constitute the undesirable class.

The rest of the population, occupying the unshaded portion of the large square, are normal people of somewhat about the average height.

Stature is convenient as a typical illustration because in this case the desirable quality, height, is capable of measurement.

APPLICATION UNIVERSAL.

If, however, any other inheritable quality be taken as an illustration, the people can, in a similar manner, be sorted out into the three classes shown in the diagram:

1. The great normal class possessing the quality in a normal or average degree.

2. The desirable class, possessing the quality in a markedly greater degree than the average.

3. The undesirable class, possessing it in a markedly less degree than the average.

On the scale shown in the diagram the desirable and undesirable classes each constitute 1% of the population and the normal 98%. Whatever may be the actual relative proportions, the diagram expresses the undoubted fact that the normal class constitutes the bulk of the population; and that the desirable and undesirable classes are very small as compared with the normal.

In the case considered the people generally have been of small stature as far back as their history extends. There has been no substantial change in the average height of the race within historical times. From this we may conclude that the ancestors of the present generation were mainly of the present normal height; and that only a few of them were much taller or shorter than this.

The above diagram, then, represents substantially the relative proportions of the three classes at each successive generation of the population. It typifies the future distribution, as well as the past, unless some means can be found to change it.

The desirable and undesirable classes, like the normal, are sprung mainly from normal parents; so that it is obvious that no process of interference with the marriages of these classes could much affect the relative proportions of the three classes in the next generation of the community. If, for example, the desirables and undesirables should all decide to lead celibate lives so as to leave no descendants, we would have just about as large a proportion of desirables and undesirables in the next generation of the community, born from the normal class.

SELECTION IN MARRIAGE.

The individuals belonging to the desirable and undesirable classes are not only few in number, but are scattered throughout the community. They appear only here and there as exceptional cases, and are not segregated from the others in their actual distribution in the population. If, then, they decide to marry, it is obvious that most of the desirable and undesirable individuals will marry normal persons, because normal people constitute the bulk of the community with whom they come in contact; and the offspring will tend to revert to the normal type of the race. From this it follows that, on the whole, the offspring of the desirables will be less desirable than themselves; and the offspring of the undesirables more desirable; most of the offspring will be of the normal type.

Given a large normal class, and two small classes, the desirable and undesirable, the problem is, how to increase the proportion of desirable children born from the normal population.

This can be accomplished by marriage with members of the desirable class.

In the typical case considered, this would mean that persons of normal height would increase their liability to have tall children by marrying tall people.

> Where normals marry normals a small proportion (say 1%) of the offspring will belong to the desirable class.
>
> Where normals marry desirables the percentage of desirable offspring will be increased (say to 10%).

Of course, it is only possible for a small proportion of the normal population to marry persons belonging to the desirable class, on account of limited numbers. The range of choice, however, may be extended by marriages with brothers or sisters or close blood relatives of desirable persons. That is upon the assumption that we are here dealing with an inherited characteristic.

PROOF OF INHERITANCE.

The late Professor W. K. Brooks, of Johns Hopkins University, said:[1]

"An inherited characteristic may, or may not, have been manifested by the parents or other ancestors. . . . If it is more common either among the ancestors or the brothers and sisters and cousins of the organism than it is in the race at large, this fact is scientific proof that it is an inherited characteristic."

Where a peculiarity manifests itself in only one member of a family we are dealing with a sporadic case; and the peculiarity may, or may not, be transmitted to the descendants: But where a number of people in the same family exhibit the same congenital peculiarity we have good reason to believe that it

[1] See appendix to Rep. Royal Comm. on Blind, Deaf and Dumb, etc., London, 1889, ii, 322; also Education of Deaf Children, Pt. II, p. 104, Volta Bureau, Washington, D. C., 1892.

is an inherited characteristic, and therefore liable to be handed down to some of the descendants by any member of the family, even by those members who do not exhibit the peculiarity in their own persons.

These considerations lead us to the conclusion that persons of normal height will increase their liability to have tall offspring by marrying into families containing a number of tall persons. In such a family the tendency to produce tall people is evidently an inherited characteristic; and the normal and undersized members of the family, as well as the taller members, will have a tendency to transmit the characteristic to some of their descendants. The tendency is in the blood, and the whole family possesses it.

INFLUENCE OF ANCESTRY.

In this connection the influence of ancestry is most marked:

(1). Where Normals (whose ancestors on the whole were normal people) marry Desirables (whose ancestors were chiefly normal), the normal partners will prove prepotent over the desirable partners in affecting the offspring. The bulk of the offspring will be normal; and only a small proportion (say 10%) desirable.

(2). But where Normals (with normal ancestry) marry Desirables (whose parents were desirable) the proportion of desirable offspring will be increased (say 20% desirable). The potency of the desirable partner to have desirable children is practically doubled, because of inheritance from both parents; and the prepotency of the normal partner is correspondingly reduced.

(3). Where Normals (with normal ancestors) marry Desirables (whose grandparents as well as parents were desirable) the proportion of desirable offspring will be still further increased (say to 45%); and the prepotency of the normal partners will be reduced almost to zero.

(4). Where Normals (with normal ancestry) marry Desirables (whose ancestors for several generations back were all desirable) it is the desirable partner who becomes prepotent over the normal partner in affecting the offspring. The vast majority (say 90%) will be desirable.

The influence of the normal partner will be less and less according to the number of desirable ancestors possessed by the desirable partner. With a sufficient number of generations of desirable ancestors, the desirable partner is what is known as "thoroughbred" in respect to the inherited characteristic. The normal partners, on the other hand, are not usually thoroughbreds for the normal condition; for if we examine their ancestors for the same number of generations back, we shall find, as a rule, that some of the ancestors were not normal: Some few were desirable, and some few even undesirable.

THOROUGHBREDS PREPOTENT.

We breeders are familiar with the prepotency of the thoroughbred animal over the normal animal; and we can therefore confidently assert that the human throughbred will be equally prepotent over the normal human being in affecting the offspring.

In spite of the smallness of the desirable class, its influence in improving the normal population would be considerable should it contain a number of highly prepotent individuals: For their marriages with normal people would result in the production of offspring almost exclusively of the desirable type (say 90 per cent. desirable). We should also remember that the brothers and sisters of the prepotent individuals will also have a strong tendency to produce desirable offspring where they marry normals with normal ancestry.

The liability of normal persons to have desirable offspring will be increased by marriages with persons of the desirable class; and diminished by marriages with undesirables.

In the latter case the proportion of *undesirable* children will be increased and if the undesirable partner is descended from undesirable ancestors the proportion of undesirable children will be still further increased.

The establishment of even a small

body of prepotent individuals within the undesirable class would exert a considerable harmful influence, because their marriages with normal persons would result chiefly in the production of undesirable children.

UPSETTING THE EQUILIBRIUM.

In considering the influence of marriage in affecting the distribution of the three classes in the next generation of the community, we may notice that in general the marriages of normals tend to keep things just as they are. That is, they tend to produce a large class of normals and two small classes of desirables and undesirables, in just about the same relative proportions as in the preceding generation.

The marriages of the desirables, on the whole, tend to raise the average of desirability in the community; and the marriages of the undesirables tend to lower it. The desirables pull the average upwards, the undesirables pull it downwards; and when these upward and downward tendencies are just equal they neutralize one another and a static condition prevails: The race as a whole neither advances nor recedes.

If the potency of the desirable class to produce desirable children is greater than the potency of the undesirable class to produce undesirable children, then we have a case of unstable equilibrium, and the whole race begins to move upwards.

Conversely, if the potency of the undesirable element is greater than that of the desirable element, then the race begins to move downwards.

Thus, it is the *difference* between the potencies of the desirable and undesirable classes that controls and determines the amount and direction of the racial movement.

If, then, we wish to improve the race the aim should be *to increase the potency of the desirable class to produce desirable children;* and this can be accomplished by promoting the marriages of the desirable with one another.

The moment we have a body of desirable persons *whose parents were also desirable*, improvement of the race begins through the marriage of such persons with the normal population: for the proportion of desirable offspring born from the normal partners will be greater than in cases where the desirable partner had no ancestors belonging to the desirable class.

The improvement will be still greater when we have a body of desirable persons who had grandparents as well as parents desirable; and still greater with each increase in the number of desirable ancestors.

Thus, the simple process of promoting the marriages of the desirable with the desirable will, through the mixture of the descendants with the rest of the population, inaugurate an improvement of the whole race; and the movement will advance with accelerated velocity as we have more and more potent individuals of the desirable class. This process continued through a number of successive generations would ultimately result in the establishment of a prepotent stock within the desirable class, and then the improvement would be very marked indeed.

CHIEF OBJECT OF EUGENICS.

Here it is to be noted that the elevating tendency is due to the desirable class alone; and that improvement depends upon *increasing the number and proportion of desirables born in successive generations of the population.* Hence, this should be the chief object of eugenics; and it is to be regretted that the efforts of eugenists have been mainly directed to the diminution of the undesirable class.

So much has this been the case that the very word "eugenics" is suggestive to most minds of hereditary diseases and objectionable abnormalities; and of an attempt to interfere, by compulsory means, with the marriages of the defective and undesirable. This relates to cacogenics ("badly born") rather than to eugenics ("well born").

The utmost that could be even hoped for from such a process would be to lessen the tendency to retrogression and degeneration; and even this result would not be attained, at least in any great degree, for the simple reason that

the undesirables, as a rule, are descended from normal parents.

Prohibition of marriage would not, therefore, have much effect upon the continued production of an undesirable class. We would have just about as many undesirable people appear in the next generation, *born from the normal population.*

Then again, the tendency to reversion to the normal type of the race is so strong that the children of undesirables are mainly of the normal type; so that prohibition of marriage would prevent the production of very many more normal children than undesirable children.

Whatever processes may be employed to improve the race, we shall always have the undesirable with us, because they are sprung mainly from the normal class; and *it is more practicable to improve the undesirable strains than to eradicate them.*

If undesirables marry normal or desirable partners they will not only have fewer undesirable children than if they married one another, but the potency of the offspring to produce undesirable grandchildren will be reduced. The undesirable blood is diluted, so to speak, by admixture with normal blood; and most of the offspring will be of the normal type.

CONCLUSION.

A public sentiment already exists that persons possessing inherited characteristics of a desirable kind should marry and have large families. This sentiment undoubtedly is favorable to the improvement of the race; but it does not go far enough.

We should impress upon the public the point that one certain means of increasing the prevalence of any hereditary characteristic in a community is to induce the individuals who possess it *to marry one another;* and thus produce a more potent stock in the next generation.

It is neither practicable nor advisable that the individuals referred to should marry exclusively among themselves, but only to a much greater extent than now prevails; and the public policy should be: Promote the marriages of the desirable with one another.

Selection by Birth-Rate

The eugenist recognizes that selection is essential to the progressive improvement of the human race, but he seeks to substitute a selective birth-rate for the selective death-rate which has been the cruel instrument used by nature.—W. C. Marshall, in the Eugenics Review.

Need of Eugenic Education

Recent investigations point with no uncertain hand to degeneracy rather than racial progress as the probable result of our existing social system. How then is this danger to be averted? The social reformer has long been busy in his attempts to improve the environment of the people; and his efforts merit our warmest approval. Progress in the evolutionary sense is, however, not certainly thus promoted, and may not be promoted at all. What we also need is an intellectual campaign, which will make the path of eugenic reform stand out more clearly in front of us by increasing our knowledge of the laws of heredity; and a moral campaign to make our fellow countrymen now ready to accept the sacrifices necessary to insure the racial progress of their country in the future.—Extract from presidential address (1913) of Major Leonard Darwin before The Eugenic Education Society, London.

THE CHESTNUT BARK DISEASE

An Undesirable Immigrant Which Has Secured Firm Foothold in Eastern United States—Breeding Resistant Species Probably the Only Solution of Problem—Opportunity for Orchardists On Pacific Coast to Build Up Industry.

HAVEN METCALF

In charge of Forest Pathology Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

IN A remote part of northeastern China, in the province of Chili, east of the Great Chinese Wall, and four or five days' journey by bullock cart from Peking, there is a little-known section of mountainous country. Here a species of chestnut, the exact identity of which is not yet known, but which may possibly be *Castanea mollissima*, grows wild on the mountain slopes and valleys and is also cultivated by the Chinese for its nuts (fig.1). These chestnut trees have a disease which in appearance is somewhat like the European apple canker, as it occurs in America on apple trees. So far as we know it does relatively little harm to the chestnut trees of China, simply producing permanent cankers on some of them, killing a few limbs, and probably occasionally killing young trees. There is no reason to suppose that the Chinese ever had any clear cognizance of it as an especially harmful agent, and it does not appear to be conspicuous enough to have attracted the attention of even the observing traveler, until it was discovered this summer by Frank N. Meyer, of the United States Department of Agriculture. Probably it is not more conspicuous than certain canker diseases of junipers in America, which have only recently been recognized and described.

It would seem at first thought that such a condition, occurring in an unknown corner of the Orient, was about as remotely connected with any practical interest in this country as the complexion of the Grand Lama. But the world is rapidly becoming a small place, and obscure facts of natural history in one remote section may become of profound significance on the other side of the globe, affecting property, health, and even life. The disease above referred to is what we now know as the Chestnut Bark Disease, and is caused by the fungus *Endothia parasitica*. This parasitic fungus appears to have been unwittingly introduced into this country, probably in the 90's or late 80's, and to have been distributed to various points in chestnut nursery stock. The parasite found the American sweet chestnut a wonderfully susceptible host, and has spread and assumed characters on this tree which, so far as we know, are wholly unparalleled in its native habitat. There were possibly many importations of this disease. Its early history in this country is obscure, and will probably always remain so. By 1903 or 1904 it was in full blast in the vicinity of New York City, and its subsequent spread is authentic history. There were other old centers, but the vicinity of New York City appears to be the oldest.

ITS DISTRIBUTION

The disease is now generally distributed in native chestnuts from Merrimack County, N. H., and Warren County, N. Y., on the north, to Albemarle County, Va., on the south. In New York the western border of distribution is sharply delimited by an area without chestnut trees—a natural "immune zone"—which extends southward along the eastern borders of Fulton, Montgomery, and Schoharie Counties nearly to the Pennsylvania line in Delaware County. Consequently, in New York the range of the disease is at present practically limited to the valley of the Hudson. In Pennsylvania the western limit of general infection is roughly along a curved line extending

A CHESTNUT GROVE IN CHINA.

The Chinese chestnut (*Castanea mollissima*) has been cultivated for centuries by the Chinese horticulturists. This photograph, sent in by Frank N. Meyer, agricultural explorer of the United States Department of Agriculture, shows the low-branching, open-headed habit of the species. Scars on the trunks caused by attacks of the bark disease can be seen plainly. Near San tun ying, province of Chili, June 1, 1913. (Figure 1.)

from the northwest corner of Susquehanna County to the eastern border of Clearfield County and on to the southwest corner of Fulton County. West of this line the advance infections were cut out by the Pennsylvania Chestnut Tree Blight Commission. The disease has not yet been found in Ohio or Indiana. In general it appears to spread northeastward and southwestward, following the direction of the ridges of the Appalachians, much more rapidly than westward, across the ridges and valleys.

Scattering infections occur outside of this area. Of these, the outposts are two infections on planted chestnuts in Franklin and Androscoggin Counties, Maine, and one infection in a nursery in North Carolina. There is reason to suppose that the North Carolina infection, and an orchard infection in British Columbia, owe their origin to trees imported directly from the Orient. The disease has not yet been reported from Europe, but its appearance there must be only a question of time.

It is difficult to estimate the financial loss which the above distribution represents, as we have no exact statistics on the value of standing chestnut timber. The estimate of $25,000,000 made in 1911 as representing the loss up to that time was probably much too conservative. But the total loss to date is insignificant compared with the loss which will ensue when the disease attacks the virgin chestnut timber of the South Appalachians. The bark disease has killed all the chestnut trees in those localities where it has been present long enough, and there is not now the slightest indication that it is decreasing in virulence or that the climate of any region to which it has spread is having any appreciable retarding effect upon it. Insects which eat the pustules of the

AMERICAN CHESTNUT ATTACKED.

This and the four following figures, showing stages in the progress of the bark disease, were taken by Professor J. F. Collins at various points on Long Island. This photograph shows where the disease has secured a foothold on some of the smaller limbs, which are quickly killed. When the infection is on the smaller limbs, however, the rest of the tree may survive for several years. (Figure 2.)

parasite have been considered as possible retarding agents, but as these same insects appear to also distribute the spores, their controlling influence is not likely to prove important.

MANNER OF INFECTION

When, in the Chinese chestnut, any spores of the parasitic fungus gain entrance into a wound on any part of the trunk or limbs, they give rise to a canker which persists on the tree, becoming deeper year by year as healthy wood is formed around it. In the American chestnut, however, the canker rapidly enlarges until it girdles the tree. If the part attacked happens to be the trunk, the whole tree is killed, sometimes in as short a time as a single season. If the smaller branches are attacked, only those portions beyond the point of attack are killed, and the remainder of the tree may survive for several years. Ultimately, however, all American chestnut trees that are attacked, die completely (fig. 5). Figures 2, 3, and 4 show the typically ragged appearance of such trees, due to the fact that some branches are not yet girdled and still have normal foliage, while others are dead.

Limbs and trunks with smooth bark soon show cankers in the form of dead, discolored, sunken areas, which continue to enlarge and become covered more or less thickly with the yellow, orange, or reddish brown pustules of the fruiting fungus (figs. 6 and 7). From these pustules masses of minute spores (conidia) are commonly extruded

SECOND STAGE OF THE DISEASE.

One after another, the limbs are invaded by the parasitic spores, and quickly succumb. A peculiar ragged appearance in the tree is produced, due to the fact that many branches have not yet been girdled by the fungus, and therefore retain their normal foliage. When the canker begins in the trunk, it rapidly extends until it girdles the whole tree, and death quickly results. (Figure 3.)

in the form of long, irregularly twisted strings or horns (fig. 6), which are at first bright yellow to greenish yellow, or even buff, becoming darker with age. If the canker is on the trunk or a large limb with very thick bark there is no obvious change in the external appearance of the bark itself, but the pustules show in the cracks (fig. 7), and the bark often sounds hollow when tapped. After the limbs or trunks are girdled the fungus continues to grow extensively through the dead bark, sometimes, if conditions of moisture are favorable, covering the entire surface with the reddish brown pustules (fig. 7). These pustules produce mostly the type of spores called ascospores. If the proper conditions of moisture are present the fungus may grow on the bark of chestnut logs and even upon bare wood.

When a branch or trunk is girdled the leaves beyond change color and sooner or later wither (figs. 2, 3, 4, and 8). These prematurely killed leaves often remain on the branches, forming, together with the persistent burs, the most conspicuous winter symptom of the disease (fig. 8). Suspicion has been recently aroused in some quarters that the dwarfed and abortive nuts in these burs may under some circumstances be unwholesome, or even poisonous, when eaten. So far, however, the evidence on this point is wholly inconclusive.

CONSPICUOUS SYMPTOMS.

The most conspicuous symptom at all times of the year is the occurrence of sprouts at the base of the tree, on the

THIRD STAGE OF THE DISEASE.

Most of the limbs have been killed, although the withered leaves may remain on them for some time afterward, and the bark may show few external symptoms of the disease. Sprouts are put out thickly at the base of the tree and in various parts of the top where there is still vitality. Any burs produced are dwarfed, but there is no evidence to prove that nuts from them are poisonous. (Figure 4.)

trunk, or on the branches (figs. 2, 3, and 4). Sprouts may appear below every canker on a tree, and there are often many such cankers. These sprouts are usually very luxuriant and quick growing, but rarely survive their third year, as they in turn are killed by the fungus. The age of the oldest sprout, as determined by the number of its annual rings, is an indication of the minimum age of the canker immediately above. The annual development of sprouts from the base of a tree has been observed to continue for at least seven years after the death of the tree. If infection of these basal sprouts could be prevented, they would develop into a much better type of coppice than is usually seen, since they are well rooted in the ground. After the tree is dead the dead sprouts on the trunk, together with the scars left by cankers on the outer layers of wood, serve to show what killed the tree long after the bark has completely decayed and fallen away.

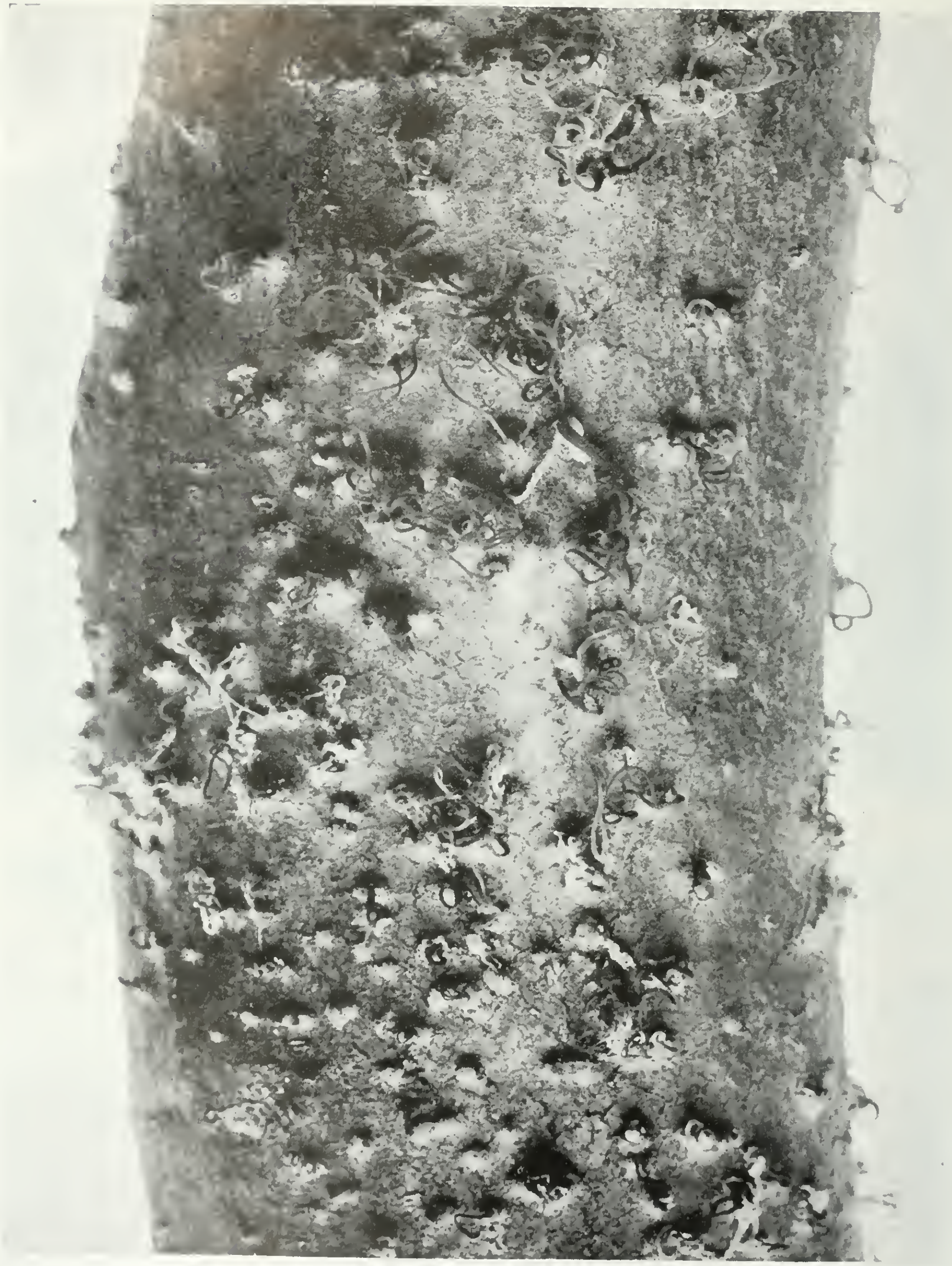
The wood is not materially injured, and may be used for all timber purposes for which healthy trees might be used, provided the diseased trees do not stand so long after they are dead that they become sap-rotted and checked. This fact greatly facilitates the prompt destruction of diseased trees, which will do much to check the rapid spread of the disease, and in localities where such work is organized under State control, as in Virginia and West Virginia, may limit it entirely. If the course of the disease is not thus checked by human effort, the complete destruction of the present stand of chestnut is a practical certainty. This will be

FINAL STAGE OF THE DISEASE.

The entire tree finally succumbs, often within two or three years after the first infection. The wood is not materially injured for timber purposes, but great care must be used in disposing of it, that the spores are not carried into new regions and set free on trees which have not previously been attacked. (Figure. 5)

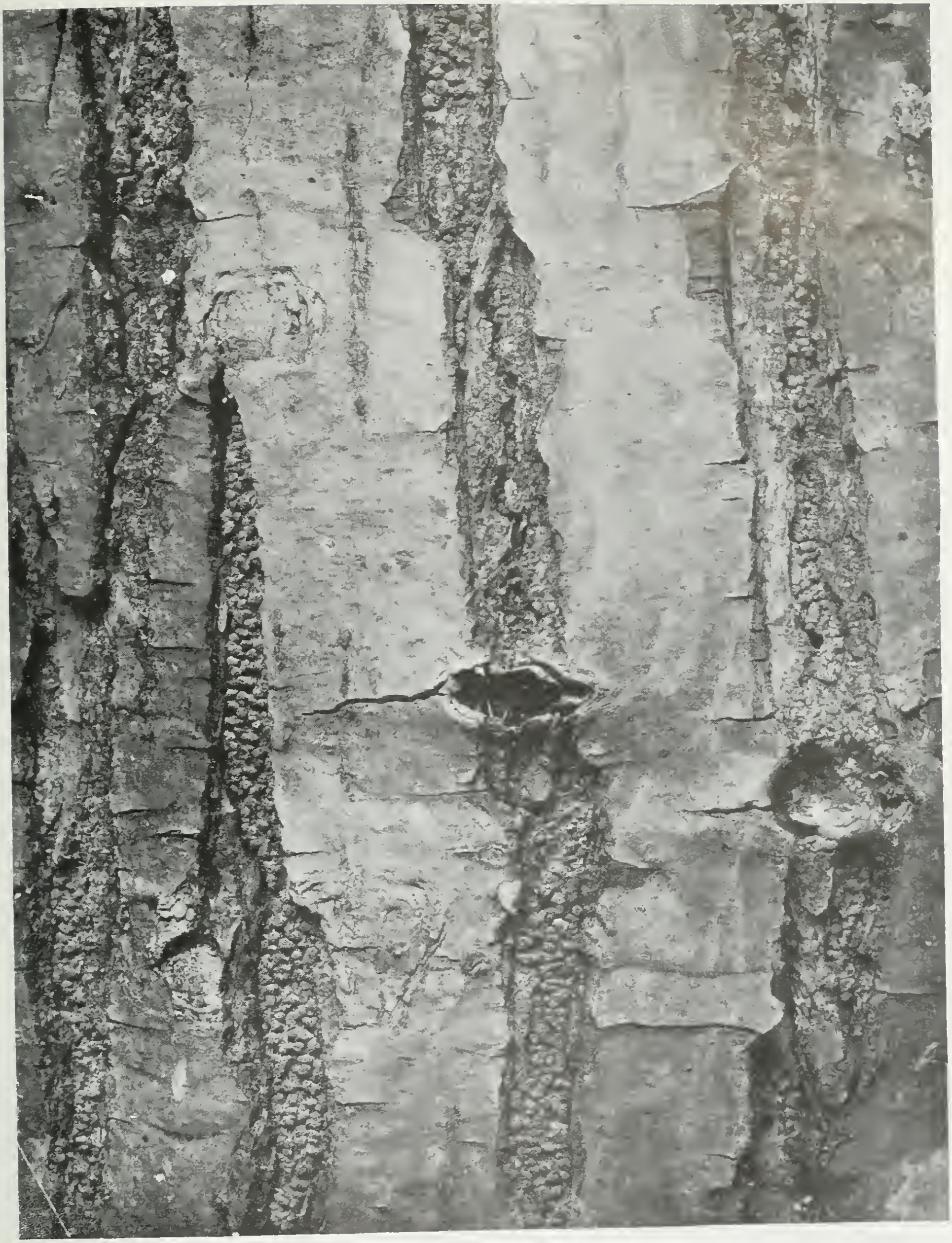
followed by a struggle between the fungus and the sprouts from the roots of the killed trees. In this struggle the marvelous regenerative power of the chestnut may enable it finally to overcome its subtle antagonist, but so far little hope of this can be held out from observation. Hundreds of chestnut trees have been under the writer's close observation since 1907, and although some have produced a new crop of sprouts each year since that time, the sprouts have rarely passed their second year without becoming diseased, or their third year without being girdled. North of the Potomac River the main problem now is how to dispose most profitably of the timber of the dead and dying trees. In Southern New England the proposition has already been made on distinguished authority, to replace the disappearing chestnut stand as rapidly as possible with white pine.

As has been indicated, diseased chestnut nursery stock has been the most important factor in the spread of the bark disease. On account of the well-grounded fear of this disease much less chestnut nursery stock is being moved now than formerly, but there is still enough to constitute a serious source of danger. It is therefore obvious that every State in which the chestnut grows, either naturally or under cultivation, should as speedily as possible pass a law putting the chestnut bark disease on the same footing as other pernicious diseases and insect pests, such as peach yellows and the San Jose scale, against which quarantine measures are now taken. Many inspectors already have the legal power



"SUMMER SPORES" OF THE FUNGUS.

These strings or "horns" of conidia are extruded from the pustules of the fruiting fungus on all the cankered limbs. At first the conidia are bright yellow or greenish yellow, but they gradually turn darker with age. These conidia are by no means always present, however, and in some cases, as in young nursery stock, it is exceedingly difficult for anyone except an expert to detect the presence of the fungus. (Figure 6.)



PUSTULES IN CRACKS OF BARK.

When the pustule attacks a large limb or the trunk, there is little obvious change in the external appearance of the bark itself, but the pustules show in the cracks of the bark, as can be clearly seen in this photograph. The bark often sounds hollow when tapped. The fungus continues to grow after the trunk is girdled, sometimes covering the entire surface with reddish-brown pustules, which produce the type of spores called ascospores. (Figure 7.)

to quarantine against the bark disease on chestnut nursery stock, and they should now take special care that no shipment, however small, escapes their rigid inspection.

A PRACTICAL DIFFICULTY.

The most serious practical difficulty in inspecting nursery stock for this, as for other fungous diseases, lies in the fact that virtually all State inspectors are entomologists and are usually not trained in recognizing the more obscure symptoms of fungous disease. Nursery trees affected by the bark disease rarely show it prominently at the time when they are shipped; the threads of conidia or the yellow or orange pustules are rarely present, and usually all the inspector can find is a small, slightly depressed, dark-colored area of dead bark, usually near the ground, which is easily overlooked or mistaken for some insignificant injury. Upon cutting into such a spot the inner bark shows a most characteristic, disorganized, "punky" appearance and characteristic "fans" of the yellow mycelium of the fungus. Occasionally a very characteristic yellowish brown or reddish band or blotch, either girdling or partly girdling the young tree, may be seen.

If infected trees are set out they develop the disease with its characteristic symptoms the following spring. On account of their small size such trees are girdled and die before the end of the summer. Meanwhile they become a source of danger to neighboring orchard and forest trees. Orchardists and nurserymen purchasing chestnut trees are therefore urged to watch them closely during the first season, no matter how rigidly they may have been inspected.

In view of the uncertain future of the chestnut tree the planting of chestnuts anywhere east of Indiana, at least for the present, can hardly be advised. West of the natural range of the American chestnut, however, the situation is quite different. Obviously the western chestnut orchardist has before him a great opportunity. No matter how successful efforts to limit the bark disease may be, the nut crop will be reduced for some years, and the business of growing fine orchard chestnuts in the East will be depressed for the same length of time. There is no apparent reason why, with rigid inspection of purchased stock and of the orchards themselves, all chestnut orchards and nurseries from Indiana to the Pacific coast can not be kept permanently free from the bark disease; therefore, all persons interested in growing the chestnut in the West are earnestly advised to be sure that stock from any source is rigidly inspected, to watch continually and with the utmost care their own nurseries and orchards, and to destroy immediately by fire any trees that may be found diseased. The discovery of an infected orchard in British Columbia indicates that other chestnut orchards will probably be found on the Pacific coast which have become infected by direct importation from the Orient.

BREEDING NECESSARY.

Probably the most practical control results in the long run will be obtained by the breeding and propagation of varieties of chestnut that are immune or highly resistant to the bark disease. Elsewhere in this magazine Dr. W. Van Fleet has described his work in this line. It appears that so far no immune or even resistant individuals of the American chestnut have been found, in spite of strenuous search; so that we must largely depend on the Asiatic varieties. The slight resistance of the chinquapin, as observed in the field, may be due only to its comparative freedom from bark insects. The species of Chinese chestnut upon which the disease occurs in China (fig. 1) is apparently resistant to the disease in that climate, but it remains to be seen to what extent this resistance will persist when the trees are grown in America. The Japanese chestnut is highly resistant, and certain strains apparently immune; these strains form at present the most hopeful basis for breeding. At present we do not know exactly what the Japanese chestnut is; most of the trees that pass under this name in the American market appear to be hybrids with the American or other varieties

DWARFED LEAVES AND BUR.

These are borne on a branch girdled by the bark disease. It has been widely reported that eating nuts from such burs produced symptoms of poisoning in human beings, and also that cases of poisoning had occured when squirrels which had fed on such nuts were eaten. There is not evidence, however, to prove either of these suppositions. These persistent, dwarfed burs with their abortive nuts are the most conspicuous winter symptom of the disease. (Figure 8.)

All of the Asiatic varieties of chestnut so far known are small trees and probably slow growing. The Chinese chestnut, or at least the variety shown in figure 1, bears nuts that are about the size of the American chestnut, or a trifle larger, and of a delicate, sweet flavor and fine texture. The Japanese varieties are also small trees and in general have large, coarse nuts, with a bitter adherent inner skin; but there appear to be some strains that are sweet. No European varieties have yet been found that are appreciably resistant. Perhaps the greatest desideratum at this time is a resistant tree of the forest type. But this may yet be found, as the world-species of Castanea are not yet assembled.

How much easier it would have been, and how much loss could have been avoided if importation of nursery stock had been safeguarded in time to have excluded this latest addition to our collection of foreign diseases and pests. Prevention is cheaper than cure; this is the first great lesson to be learned from the invasion of the chestnut bark disease. It is too late to exclude this undesirable citizen; but we can at least redouble our efforts to see that no others get a foothold on this continent.

Inheritance of Milk Yield

Inheritance of the property of milk production in a registered herd of cows in East Prussia is discussed by J. Peters in Nos. 11, 12 and 13 of the Deutsche Landwirtschaftliche Tierzucht, Hannover, Germany, 1913. His data show great variations in the inheritance of milk yield. The offspring of the best mothers yielded, on the average, the most milk and those of the inferior mothers least. The range of variation was not, however, so great among daughters as among mothers. First class cows produced both good and inferior offspring, and *vice versa*. The inheritance varied around a center, which was somewhat higher in the daughters of superior mothers than in those of inferior cows. The magnitude of the variation was the same for all classes.

Peters then determined the milk production of the grandparents and of the separate families of the herd. With regard to the families, he found that some produced relatively many good animals, while the descendants ot others were usually inferior cows; in other families, again, he observed unusually large variations in the performance of the offspring. As a rule, however, the offspring of good families were good milkers and those of inferior families unsatisfactory. Inheritance varied in the case of mediocre families.

The writer comes to the conclusion that it is not sufficient to estimate the absolute and relative yield of cows, and upon these data to select the offspring of the best *individual* performers for further breeding, but it is necessary to select the *best families*, for among the descendants of these will be found the largest number of good milch cows. His data are summarized in the Bulletin of the International Agricultural Institute, Rome.

The Improvement of the Human Race

The improvement of the breed of mankind is no insuperable difficulty. If everybody were to agree on the improvement of the race of man being a matter of the very utmost importance, and if the theory of the hereditary transmission of qualities in man was as thoroughly understood as it is in the case of our domestic animals, I see no absurdity in supposing that, in some way or other, the improvement would be carried into effect.—Francis Galton, in Macmillan's Magazine (1865).

CHESTNUT BREEDING EXPERIENCE

How the American Chestnut, Threatened by Extinction, May Be Saved to Horticulture, Even if not to Forestry — Promising Crosses Between Chinquapin and Asiatic Species—Trees Bear Early, Produce Good Nuts and Show Resistance to Blight.

Walter Van Fleet

Physiologist, Office of Drug Plant Investigations, Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C.

THE advent about twenty years ago of certain large-fruited and early-bearing chestnut varieties of the European and Asiatic types, some appearing to be natural hybrids between the exotic species and our native sweet chestnut, *Castanea americana*, suggested to the writer the possibility of breeding all accessible species of the genus in a systematic manner. Between the years 1894 and 1911 many careful pollinations of the native species, including the bush or Virginia chinquapin, *C. pumila*, were made, using the European and Asiatic varieties then obtainable. Some cross-breeding within the species for the purpose of improving quality of nuts and accentuating the early bearing propensities of the Japan and European types was also attempted. The result of these undertakings have been successful, in the main. The appearance in 1907 among our plantings of the terribly destructive new bark disease organism, *Endothia parasitica*, put a summary termination to the experiments with *C. americana* and its derivatives, but selection work has since continued with self- and chance-pollinated individuals of the chinquapin and Asiatic types.

The method pursued in hybridizing was carefully to cut away, as they appeared, all traces of the male catkins or aments and to enclose the selected branches as soon as pistillate blooms were visible in roomy paper bags which were kept on except during pollination until the stigmas withered. The chinquapin crosses were made on a particularly productive and precocious plant grown from seeds collected in Virginia in 1889. The entire bush was systematically emasculated each flowering season, every branch being gone over daily, so that no pollen whatever was liberated, and protection from wind and insect-borne foreign pollen was further assured by covering the bush during bloom with a cheese-cloth tent in addition to the paper bags on separate branches. Pollen was secured by gathering catkins in early morning from desired species and varieties and allowing the anthers to dehisce in a sunny window protected from flying insects of all kinds. Applications to the stigmatic surfaces were made by means of the brush, finger tip, and by flicking or lightly drawing the catkins over the stigmas where pollen could be plainly seen coating the anthers. All these methods proved measurably successful but the latter gave, on the whole, the best results.

HYBRIDS PRECOCIOUS

About thirty per cent. of these controlled pollinations produced viable seeds and practically all the seedlings grown—over two hundred in number—showed unmistakable evidence of hybridity. Nearly all have fruited, the chinquapin-Asiatic crosses often bearing nuts the third year of growth, while the combinations of Asiatic and European chestnuts with our native species rarely set burs until five to twelve years old. The cross-bred Japan varieties show greatest precocity, frequently blooming and occasionally ripening nuts the second year after germination, and in a few instances producing several pounds of nuts the following season, three years after planting the seeds.

A VIGOROUS HYBRID CHESTNUT

The second generation, four years old from self-pollinated seed, of a hybrid between the American chinquapin (*Castanea pumila*) and the Japanese chestnut (*Castanea crenata*). In addition to its blight resistance, the hybrid is valuable because it ripens its nuts early in the year. (Figure 9.)

A HYBRID CHINQUAPIN

These nuts are produced by a seedling which was grown from the cross between the shrubby American chinquapin and the Japanese chestnut. Three nuts are usually borne in each bur, and they are larger in size than those produced by any of the native American species. Photograph natural size. (Figure 10)

The bark disease has been allowed to work its will among the hybrids with the result that trees having *C. americana* in any combination have nearly all disappeared. Seedlings of Paragon chestnut, the best variety of the European type, pollinated with our native species, attained an average height of twenty-five feet and were bearing excellent nuts when attacked in 1910, but all have succumbed. The crosses of Asiatic and native, fewer in number, showed greater resistance but all have been seriously affected. The chinquapin-European hybrids are readily affected but have great recuperative powers, bearing nuts the second year on suckers springing from the bases of diseased stems. Chinquapin-native crosses, with the exception of the Rush chinquapin—a probable natural hybrid found wild in Pennsylvania—appear very susceptible and do not as readily recover. The wild chinquapin itself appears measurably resistant, several individuals, including two Rush chinquapins, thriving for years with no signs of disease though constantly surrounded by infection.

The Asiatic chestnuts, and the chinquapin-Asiatic hybrids, are plainly highly resistant. Few have shown any appearance of infection and when noticeable the injury is quite local in character. Second generation seedlings of chinquapin-crenata crosses show no disease at all though always exposed to infection.

QUALITIES OF HYBRIDS

The material results of this breeding work, other than the disease-resisting features, are shown in the various illustrations accompanying this article. Hybrid chinquapins having varieties of *Castanea crenata* for the pollen parent form vigorous, small, much branched trees, rarely shrubs, and come into

A FOURTH-GENERATION TREE.

This cross-bred Japanese chestnut (*Castanea crenata*) is only twenty-three months old from seed, but is blooming and bearing ripening nuts at the same time. Trees with this pedigree usually flower the second season, showing greater precocity than any others with which experiments have been made; in a few instances they have produced several pounds of nuts in the third season after the seed was planted. (Figure 11.)

bearing at three to five years from the seed. They bloom profusely, bearing long chestnut-like catkins as shown in plate 11. The burs are borne like chinquapins in clusters or racemes of three to five or more, rarely solitary, and contain from one to three chestnut-like nuts four to six times larger than chinquapins.

Nuts of the various species and types, freshly collected and without selection as to size, averaged in weight as follows:

100 nuts	Chinquapin	100 grammes
" "	Native Chestnut	395 "
" "	Hybrid Chinquapins	613 "
" "	Japan Chestnut (pollen parent)	1024 "

The first second-generation hybrid to fruit in quantity bears nuts weighing 416 grammes to the hundred. They show a tendency to increase in size and weight as the tree develops. The appearance and relative sizes of the various nuts are well shown in the accompanying plates.

The time of ripening is very early, forestalling even the wild chinquapin, as the first burs open late in August, the crop being wholly mature by October without frost, thus preceding all other chestnuts of marketable size. The nuts are handsome in appearance, smooth, dark brown in color, with very slight tomentum, and as they possess

TWO WILD CHESTNUTS AND A HYBRID.

In the center is the nybrid produced by a cross of the wild American chinquapin (*Castanea pumila*) and the Japanese chestnut (*C. crenata*). At the left is the ordinary American chestnut (*C. americana*) as produced in forests. At the right is the wild American chinquapin (*C. pumila*), which is valuable in crosses because of its vigor and adaptability to the climate, although its nuts are too small to be of great value, as produced by wild trees. Photograph natural size. (Figure 12.)

THE HYBRID AND ITS PARENTS

In the center is one of the first nuts produced by the cross between the wild American chinquapin (shown at the right) and the Japanese chestnut at the left. The nuts of the hybrid are midway in size between those of its parents, but in maturity and blight resistant qualities, it seems to combine all the good characteristics of both ancestors. Photograph natural size. (Figure 13.)

thicker shells than chestnuts, they keep their fine appearance under exposure much longer. The quality appears to vary slightly according to the immediate pollen parent, but is quite comparable to that of our best wild chestnuts—not quite as sweet as the little wild chinquapins, but good enough when cured to be enjoyed thoroughly without cooking. There are none of the starchy and tannin-like flavors so common with the larger European and Asiatic chestnuts and no hint of bitterness in the inner skin as with the immediate pollen parents.

TREES ARE VALUABLE.

The trees are vigorous growers, decorative from their compact form at all times, but especially so when in fruit and flower. They should prove highly desirable for lawn planting as well as for nut growing. The size they would ultimately attain, if continuously free from disease, is problematical. The tallest is about nine feet high and eight in spread of branches at nine years from but the seed, was once transplanted under retarding circumstances. Their precocity and profusion in fruiting would indicate that the trees are not likely to attain large dimensions and that it would be safe to plant them for orchard purposes at least as near together as peach trees—say twelve to fifteen feet apart. Propagation of particular varieties has not yet been attempted, but it is to be expected that they may readily be grafted on seedling chinquapins or resistant stocks of the Asiatic types.

It is to seedlings of these hybrids, however, that we may reasonably look for greater variation than is likely to be had from direct hybridization of the species. The germination percentage of the hybrid nuts is rather low—there appears frequently a poor connection between the embryo and the endosperm—but about half produce vigorous seedlings with very diverse foliage, resembling beech, oak and holly leaves rather than chestnuts in the juvenile stages. By the second year the foliage segregates into the chinquapin type with slight, light tomentum on the under surfaces and that of the chestnut, larger and clear green on both sides, accompanied with the characteristic branching of the respective types.

The pollen parents of the best chinquapin hybrids, with few exceptions, were home raised varieties of *C. crenata* and quite likely are themselves hybrids with our native chestnut, as the two species are believed to intercrsoss readily when grown near together. The slight susceptibility of the chinquapin hybrids to the bark disease—not greater, certainly than that of the Keiffer pear to the bacterial pear blight—can thus readily be explained. The breeding of selected chinquapins with pure Asiatics, particularly of the Chinese forms that are thought to be highly resistant, might afford even better results than have yet been secured in regard to this feature.

A very promising Chinese chestnut, already given the provisional name of *Castanea mollissima*, is now being established through the efforts of the Office of Foreign Seed and Plant Introduction, and will soon be available for breeding purposes. While scarcely a timber tree as compared with our native species, it is nevertheless of good dimensions and apparently a quick and thrifty grower. The nuts are of really excellent quality, though of only medium size, and are said to be produced freely at a comparatively early age. The especially promising quality, however, is a marked resistance, as demonstrated by experimental inoculations that have so far caused little harm, to the Endothia disease.

Chestnut breeding, though greatly hampered by the advent of the new disease, thus makes its appeal as a highly promising occupation. It appears probable that the chestnut in its most desirable form can be saved to horticulture as a nut producer if not to forestry as a profitable timber tree, and there is even a chance that the latter highly important feature may in the end be spared.

The Origin of Species

How a three-horned species of bull (*Bos triceros*) "originated" in Senegambia and was accepted by the leading scientists of the world, is amusingly told by Th. Monod and G. Moussu in the Bulletin de la Société Nationale d'Acclimatation de France, 15 September, 1913. The species was first announced by the distinguished zoologist de Quatrefages, in the name of Dr. de Rochebrune, in 1880.

In 1885 Dr. de Rochebrune discussed the possible origin of this third horn, which was on the face of the animals. He decided that it was a typical specific characteristic, and his opinion has always been accepted.

It now appears that this horn is merely the result of an inoculation which has been practiced upon many of the cattle of Senegambia since 1864, as a preventive against peripneumonia. An incision is made in the face of the animal and serum injected; the resulting inflammation causes the appearance of a bony projection covered by a horny mass, which has outwardly the appearance of a true third horn. A dissection at once shows, however, that it is merely an excretion.

It will be necessary, then, for students to scratch *Bos triceros* off the list.

An Explanation of Graft-Hybrids

M. Lucien Daniel has made a communication to the "Academie des Sciences" from which it appears that the anatomical examination of grafts of Helianthus on Helianthus and of Opuntia on various cacti has revealed to him the existence of internal adventitious roots formed in the stock and penetrating to various depths in its tissues. Occasionally these roots even reach the soil and bestow complete independence on the graft. M. Daniel considers this to be the probable explanation of certain cases of hybridization through grafting—Journ. Soc. Nat. Hort. Fr., June, 1912, quoted in Journ., R. H. S., Aug., 1913.

Galton's View of Eugenics

I take Eugenics very seriously, feeling that its principles ought to become one of the dominant motives in a civilized nation, much as if they were one of its religious tenets.—Francis Galton.

The Scope of Eugenics

Charity refers to the individual; Statesmanship to the nation; Eugenics cares for both.—Francis Galton.

CHESTNUT BLIGHT RESISTANCE

Castanea Alnifolia and C. Mollissima Show No Signs of Blight—American Chinquapin Seems Almost Equally Vigorous—Japanese Varieties Usually Succumb—Experiments Prove Nuts Develop Freely When Female Flowers Are Not Pollinated.

Robert T. Morris, M. D., *New York, N. Y.*

EIGHT years ago, when the chestnut blight (*Endothia parasitica*) began seriously to menace my native chestnut forest, situated in the towns of Stamford and Greenwich, Conn., notes were made upon the subject and a number of varieties and species of chestnuts were added to the collection. At that time there were about five thousand old American chestnut trees (*Castanea americana*) upon my country place; there were also half a dozen chinquapins (*Castanea pumila*) about five years of age, and a few grafted trees of named varieties of chestnuts which had been purchased from nurserymen at about the time when the chinquapins were purchased. There were two saplings of *Castanea mollissima*, the Chinese chestnut, which had been given me by Professor C. S. Sargent.

None of these notes in relation to ages of trees and numbers of trees, which follow, are quite scientifically accurate, because as a busy man with many kinds of responsibilities, the matter of records has been left to employees. Changes in the meantime have taken place among the employees. I am writing from memory, rather than from notes, when making this contribution.

When it became evident that the American chestnut trees on my place were seriously menaced, the question of finding blight-resisting individuals among species and varieties came up, and I proceeded to add to the collection various species and varieties until it included twenty-six different kinds. Among these kinds, species were as follows: American sweet chestnut (*Castanea americana*), bush chinquapin (*Castanea pumila*), tree chinquapin (*Castanea pumila arboriformis*), alder-leaf chestnut (*Castanea alnifolia*), evergreen chestnut (*Castanopsis chrysophylla* or *C. sempervirens*—I do not know which species). In addition to these American species of chestnut there were two specimens of *Castanea mollissima*, and many specimens of species not determined by me, from England, France, Italy, China, Korea and Japan. There were also a number of grafted varieties of descendants from European and Asiatic progenitors.

PROGRESS OF DISEASE.

The fate of these chestnuts may be briefly summed up at the present time about as follows:—

The evergreen chestnuts (*Castanopsis*) which I set out on several different occasions, were always eaten during the winter or spring by cattle or by rodents, on account of their attractive green leaves and tender shoots above the snow, notwithstanding various attempts at protection.

Every one of the five thousand old American chestnut trees became blighted, and they were removed. Younger trees and stump shoots of the American chestnut are now practically all dead or dying with the blight.

Various grafted varieties of European and Asiatic chestnuts have shown

GIANT CHESTNUT IN EASTERN CHINA.

Although the bark disease is found in the groves of this region, the Chinese species (*C. mollissima*) seems to have acquired a high degree of immunity to it. This photograph, taken at San tun ying, province of Chili, shows scars on the tree, where the disease has made its appearance but been overcome. A large number of seeds of trees of this species have recently been introduced by the department of agriculture and distributed among investigators in the United States. (Figure 14.)

different degrees of resistance to the blight. Some of them which show an occasional blighted limb may be preserved with a moderate degree of care. This is also true of the seedlings of European and Asiatic varieties. None of them appear to be as vulnerable as the American chestnut, but most of mine are dead nevertheless.

Korean chestnuts and chestnuts from the Aomori region in Japan resisted the blight almost completely until they were six years of age. Since that time they have shown a marked tendency to blight, but resist it better than does the American chestnut.

Korean and Japanese chestnuts when grafted upon American chestnut sprouts all blighted in their second or third year after grafting while their "parents" remained unblighted, indicating that the sap of the American chestnut furnishes attractive pabulum for Endothia. American chestnuts grafted upon stocks of Korean and northern Japanese chestnuts showed a marked tendency to blight promptly, near the point of union of the graft, while the stocks remained unblighted.

One hybrid between the American sweet chestnut and the chinquapin blighted when about eight years of age and is now dead.

None of the American species of chinquapin, varying from five years to about thirteen years of age, has blighted, with the exception of two limbs, which were injured by falling limbs of a blighted American sweet chestnut tree. These injured and blighted branches were removed and there has been no other blight among the chinquapins.

TREE SCRAPED TO PREVENT DISEASE

The Chinese method of warding off attacks of the bark disease from their commercial plantations is to keep the trunk and larger limbs scraped clean, thus giving the spores of Endothia little foothold. This photograph illustrating the application of this crude method of prevention was taken at San tun ying, province of Chili, China, by Frank N. Myer, June 1, 1913. (Figure 15.)

Of the two which were injured one was a bush chinquapin and the other a tree chinquapin.

I purposely allowed dying American chestnuts to remain near the experimental test species and varieties in order to make the test severe. None of the specimens of *Castanea alnifolia* has blighted. None of the specimens of *Castanea mollissima* has blighted but these latter include only five trees—the two given me by Professor Sargent (now eight years old) and three received since that time from the Bureau of Plant Industry, Washington.

BREEDING EXPERIMENTS.

In order to breed hybrid chestnuts which would be resistant to blight, I made various combinations between staminate and pistillate flowers of *Castanea alnifolia*, *C. pumila* and *C. mollissima*. The most promising hybrid for timber purposes would presumably be one between *C. mollissima* and *C. pumila arboriformis*, but my tree chinquapins came into flowering this year for the first time. Next spring I shall make that combination. There are now growing in my collection various young hybrids between *C. mollissima*, *C. alnifolia* and *C. pumila;* likewise a number of other hybrid chestnuts, but these are at present from one to three years of age only and are of no value for data in reference to blight resistance.

When making hybrids between various species of chestnuts, I incidentally determined that parthenogenesis apparently occurs among the Castaneas. Three years ago a number of pistillate flowers of *Castanea pumila*, which had been covered with paper bags, were not pollenized for the reason that I did not happen to have pollen enough to go around. These paper bags were left in place unintentionally. Some three weeks later when they were removed because of unsightliness, the branches which had been covered with paper bags were found to have set full complements of nuts. These nuts went on to full development and were fertile—sprouting later. Some of them showed peculiar freaks. Cotyledons protruding through the involucre before the nuts were fully developed showed a trifle of chlorophyll coloration similar to that of the germ, which also protruded beyond the involucre. Another peculiar feature of the parthenogenic nuts was the disparity in size between shoots which grew from them in the following year, some becoming much larger and some remaining smaller than chinquapins growing from normal gametes. In order to make sure that no pollen had accidentally reached the pistillate flowers by way of insects or wind, carefully checked experiments were made in the following year, and so far as I can judge there is no doubt but the American chinquapin may develop its fruit freely by parthenogenesis or by formative budding from some cell.

Incidentally I may state that similar experiments were tried with *Juglans cinerea*, *Hicoria ovata*, *H. glabra*, and *H. minima*, and all of these apparently developed nuts by parthenogenesis, *Juglans cinerea* freely, and the three hickories sparingly.

The Supremacy of the Mind

We cannot raise the race by degrading individuals. Whatever lowers the humanity of fathers and mothers, whatever elevates the physiological above the psychological, the body above the mind, is an enemy of the race and no method for its regenerators.—C. W. Saleeby: The Methods of Race-Regeneration (1911).

The Biometric Standpoint

General theories of society are of no use, verbal discussions are of no use, philosophical reasoning is of no use. We need to observe, measure and record, to analyze by the methods of exact science, before we can advance in our sociology, before we can aid our working classes to a true insight of the factors which make for or mar our national vigor.—Karl Pearson: Nature and Nurture (1910).

EUGENICS AND BREEDING

Methods Used In Improvement of Plants and Animals Can Not Be Applied Directly to Improvement of Human Race, Since Object is Different—Diversity In Man To Be Encouraged—Cultivation of Eugenic Instinct More Important to Future of Race Than Weeding Out Defective Persons.

O. F. Cook,

Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

THERE is a popular idea that the human race is to be improved by a direct application of the methods of breeding that have given such valuable results in the improvement of plants and animals. It is unfortunate that this idea should gain currency, for a misleading impression of eugenic reform is conveyed. The difficulty of applying to mankind the same methods of breeding that are used with plants and animals has been considered by some writers as an obstacle to human progress, but in reality it would not be desirable to apply breeding methods to mankind, even if it were possible to do so.

The chief object of plant and animal breeding has been to secure uniformity, that is, to induce the expression of the same characters in all the members of a select group. In dealing with our domesticated plants and animals, uniformity represents the ideal condition of heredity because it means larger crops or a more valuable commercial product. Most of our boasted improvements of plants and animals are of this nature, and represent higher degrees of uniformity, rather than more advanced stages of evolutionary progress.

Nothing may be said of uniformity when breeders and fanciers are competing in the production of superlative, high-performance individuals, but everybody understands that the breeding value of a superior animal or plant depends upon its "transmitting power," meaning the regular appearance of the desirable characters in the descendants. A variety with a low average would not be popular even though it might produce occasional prize-winners. Plant breeders have taken uniformity most definitely into account, but the principle has been recognized for a longer period of time among animal breeders.

The development of an improved variety begins with the finding of a superior individual to serve as a parent. The skill of the breeder is shown in preserving the characters of this superior individual and developing a uniform race, all showing the same desirable characters as the select ancestor. Thus the art of breeding improved varieties is to substitute uniformity for diversity.

DIVERSITY IN NATURE.

Whenever we gain sufficient familiarity with a wild species or an unselected stock, a condition of individual diversity is found, like that with which we are familiar in the human species. It is this diversity that the breeder has learned to suppress. The method is to restrict descent to narrow lines, or even to a single parent, when self-fertilization or vegetative propagation can be practiced.

Viewed from this standpoint it is obvious that there is no agreement or even close analogy between breeding and eugenics. The objects of the two are almost diametrically opposed. The difficulty of applying the breeders' methods to the human race need not be considered as an obstacle to eugenic reform, because nobody would wish to parallel the breeders' results, so as to substitute for the present individually diversified human race a few uniform varieties composed of duplicate individuals.

Eugenic reform is not likely to attain very wide popularity if it is expected to result in a condition in which all the children of a family are to be as much alike as twins. Yet this is the ideal of the breeder, and the end that is attained by the application of the breeders' methods of improvement. Hence we may expect that a more adequate study of the problems of eugenics will lead to the development of methods altogether different from those that are in use among breeders of plants and animals. Progress must be made in eugenics without destroying or even seriously diminishing the normal individual diversity, that feature of human heredity with which we are most familiar.

A clear understanding of the nature, conditions, and causes of organic evolution is even more important for the eugenist than for the breeder. With the condition of individual diversity retained, the eugenic progress of mankind will have much more analogy with the normal evolutionary progress of wild species of plants and animals than with the breeding of uniform domesticated varieties. Too many writers on eugenics overlook the need of a broader and more truly biological point of view, and restrict their attention to the facts of heredity that have been learned from garden or laboratory experiments with domesticated forms.

The select strains that breeders develop from single superior individuals do not represent permanent steps in the evolution of the species, and often endure for only a few generations. New varieties are brought forward continually to take the places of those that drop out. Thus from the standpoint of the species, the breeder may be said to destroy the best individuals when he uses them as the parents of short-lived varieties. We are now beginning to appreciate the importance of preserving the wild, unselected types of our domesticated plants and animals, to serve as storehouses from which vigorous new varieties may be drawn as needed in the future.

ELIMINATION NOT ENOUGH.

In the conscious improvement of mankind the permanent interests of whole nations or races have to be considered instead of the formation of specialized short-lived varieties. It will not be sufficient to eliminate the conspicuously defective individuals as a plant breeder rogues out the "off" plants in attempting to preserve a variety from degeneration. Guarding the fertility of the best is a much more important issue than destroying or sterilizing the defectives. Galton's mastermind perceived this clearly enough, but many of his avowed followers have been impressed too much by the analogies of breeding.

If the objects and methods of eugenics are to be different, what have students of eugenics to learn from the breeding of plants and animals? The answer is that the same natural laws or relations seem to be manifested in the development of mankind as in the heredity and evolution of the lowest orders of plant and animal life. It is through the study of breeding that nearly all of our more definite knowledge of heredity has been gained in the past and that increase of such knowledge may be expected in the future. As far as eugenics is to be considered as a branch of biological science, it can not afford to neglect any facts or suggestions that may be developed in any other part of the biological field.

The time may come perhaps, when eugenics can be studied as a separate branch of heredity, without reference to the breeding of plants and animals, but for the present, and for many years in the future, the plants and animals must afford our best opportunities for gaining new experimental knowledge of heredity. It would be as far from the truth to suppose that the plants and animals can be neglected by eugenics as to suppose that the plant and animal methods can be applied directly to mankind.

The recently awakened interest in eugenics means that the future progress of humanity is to be aided by a conscious recognition of heredity as another chapter of the laws of nature that we must learn to obey. Thus far we have been content to float unconsciously, as it were, down the stream of life, feeling no creative responsibility for the future

of our race. Though often making much of our moral responsibility, and of the possibilities of attaining to some other existence after the life of this world, we have been accustomed to think of the future of mankind as something essentially beyond our control. That we have a biological responsibility for the generations that are to come is a new idea for our race. In this perception our wise men remained far behind the sages of ancient Greece, where racial improvement was recognized as one of the chief duties of patriotism.

IMPORTANCE OF HEREDITY.

But now we have begun to see that it may be possible, by taking thought of heredity, to navigate the stream of life with greater safety and avoid some of the whirlpools, rocks and quicksands which have destroyed our predecessors. And we see too that our race has reached the stage of development where civilization begins to be destructive, by interfering with the processes of natural selection that guide the progress and guard the strength of primitive peoples. Many forms of weakness and degeneration are arising and being preserved amongst us.

Yet the first stage of awakening to our eugenic responsibilities even brings new dangers. Anxiety to atone for past neglect and zeal of a new cause may lead eugenic reformers to attempt to seize the rudder before they learn what course to steer. This danger of premature interference with our social system on the ground of eugenic reform might be illustrated by many of the suggestions that are made along the line of direct application of animal breeding methods to mankind, not to speak of suggestions that are justified by nothing that we know of plant or animal breeding. Pity and prudence alike demand that useless suffering be avoided by reducing the proportion of deformed, defective or constitutionally diseased. However important this may be, it represents, after all, only the first or preliminary stage of eugenic responsibility and may even misrepresent the true objects and ideals of the eugenic movement. Sterilization of criminals and defectives would be one way to diminish the populations of prisons and asylums and thus reduce the taxes that future generations must pay, but to urge such measures on the ground of eugenics is like recommending house-cleaning as a substitute for architectual skill in building the houses. If our eugenic sensibilities were more highly developed the progress of the race would not be endangered by the propagation of defects and abnormalities.

The investigation of abnormal heredity can be described as eugenics only by way of contrast and precaution, and should not be allowed to displace the primary idea of eugenics as an investigation of the possibilities of constructive improvement of the race. It might be better if the study of hereditary defects in mankind were recognized as a separate branch of biological science under such a name as dysgenics or cacogenics, just as teratology is treated as a special branch of plant and animal morphology. Dysgenics would relate more properly to the study of defects as such, cacogenics to the production of the bad instead of the good, as when selection is reversed and the weak multiply instead of the strong.

EUGENICS NOT DYSGENICS.

Whatever the names, it is certainly most unfortunate to allow the general public to gain the idea that eugenics is a study of diseases and abnormalities. Yet this impression is frequently reflected in the public press and even in the comic journals. The middle-aged aunt is pictured as saying to the sweet girl graduate, "My dear, what a great deal of unpleasant knowledge you seem to have." "Yes, Auntie, but you know I've done a lot of work in eugenics."

Deformity, degeneration and disease are unpleasant ideas, but progress and perfectibility are not. The real question, of course, is not whether facts are pleasant, but whether we are giving attention to the important facts, those that will enlighten our judgment in dealing with eugenic problems. To dwell much upon the wrong facts may be worse than leaving the whole matter alone.

To specialize on the dysgenic features and leave the constructive eugenic ideas out of account is to neglect the most important lessons of organic evolution, as well as the best reasons for taking interest in eugenics. Higher appreciation of human nature in its normal perfection might be trusted to inspire the strongest motives of eugenic behavior, both in the individual and in the race. To develop eugenic perceptions and instincts is even more important than to magnify the idea of eugenic responsibility. There is no reason why eugenic appreciation of the perfection of human life should fall behind the artist's joy in painting pictures or carving ideal forms in stone.

Young men and women who prize life highly enough will not be tempted to choose weak, diseased or defective partners, or to take the risk of bringing crippled or weak-minded children into the world by marrying into families that have shown hereditary abnormalities. If our young people saw clearly and felt deeply that healthy, intelligent, affectionate children are the most precious of all possessions, they would perceive also the suicidal nature of dysgenic behavior. They would see that in disregarding the facts of heredity, now that the inheritance of defects is definitely known, they are forfeiting the right to the supreme happiness of life that normal children may bring. To the enlightened eugenic conscience it will be plain that the sins of the father are not visited on the children alone, but upon the parents as well.

More Knowledge Necessary

Except in very few cases, our knowledge of heredity in man is at present far too slight and uncertain to base legislation upon.—Professor R. P. Punnett, Cambridge University, England.

Eugenic Instinct Natural

The natural man and the natural woman are Eugenists at heart. Each of them prefers, in members of the opposite sex, youth and maturity rather than senility, beauty (which has a high degree of correlation with health) rather than ugliness, straightness and efficiency of limbs and feature rather than deformity, optimism rather than pessimism, intelligence, good temper, sympathy rather than their opposites. There is indeed, speaking in popular language, a eugenic sense; and the business of those who undertake the great task of education for parenthood is to educate—that is, to lead forth and develop—this sense, and, in the first place, to oppose and if possible destroy all those agencies, chiefly servants of mammon, by which the growth of this most precious element in our nature is vitiated or arrested. —C. W. Saleeby: The Methods of Race-Regeneration (1911).

MEAT PRODUCTION IN SWAMPS

Introduction of Pigmy Hippopotamus Offers Opportunity for Utilization of Large Areas in Southern States to Produce Excellent Meat at Low Cost—Difficulties of Securing Breeding Stock at Last Overcome.

WHILE most of the work of plant and animal breeders has, in the last analysis, the production of cheaper food by increasing the supply, as its object, there is one opportunity in the United States which has been entirely neglected. This lies in the large areas of swamp land in the southern states, which at present are economically almost worthless, and which cannot be reclaimed to ordinary agriculture except at great cost. If this land could be made directly useful in the production of meat, it would appear to be a desirable enterprise from every point of view.

Such a possibility was clearly outlined by the late W. N. Irwin, before members of the American Breeders' Association[1] several years ago, in a discussion of possible increase of meat production in the United States by the introduction of mammals not now found in this country. He remarked:

"In selecting other species for introduction, it is very important that we consider the food supply that they will require. We have several large areas well adapted to certain kinds of animal life, and not now producing, for the reason that the animals are not there. The area of greatest promise is in our gulf states, and consists of over 10,000 square miles (6,400,000 acres) of water and marsh surface, with a sufficient quantity of marsh grass, water hyacinths and other aquatic plants now growing to support thousands of animals adapted to those conditions. If properly seeded to water hyacinth and other aquatic plants, this vast region would be capable of producing a million tons of meat per annum, worth $100,000,000. This area should be stocked with hippopotamus (*Hippopotamus amphibius*), the flesh of which is highly esteemed, and when salted and cured, is known in the Cape of Good Hope as Zee-Koe Speck (lake-cow bacon). The fatty mass lying between the skin and the flesh or muscles is considered one of the purest of animal fats, and is in great demand among the cape colonists. These massive animals were to the English settlers in Cape Colony what the buffalo was to the pioneers in the settlement of our great prairies, and like the buffalo were almost heedlessly exterminated."

DIFFICULTIES PRESENTED,

Mr. Irwin's proposition never met with acceptance, as it was immediately pointed out that the hippopotami would be impossible to control. The introduction to the United States of the pigmy hippopotamus of Liberia, however, offers an animal that can be easily controlled and kept in fences, furnishes excellent meat, and may have a real economic future under such conditions as Mr. Irwin outlined.

This hippopotamus (*H. liberiensis*) is

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[1] Irwin, W. A. Animals that should be introduced and bred for economic and profitable meat production. A. B. A. annual report V, 214.

PAIR OF PIGMY HIPPOS IN NEW YORK PARK.

Although wild and difficult to capture, they have proved rather easily handled, and did not suffer from the hardships of transport from inland Liberia to the United States. Hans Schomburgck, the envoy of Carl Hagenbeck who secured these specimens, managed to tame a full-grown bull only a few days after he had captured it. (Figure 16.)

ignored in most scientific works[2], and to be found in few zoological parks. The New York Zoological Society now possesses three, however, which have aroused the interest of practical breeders as well as zoologists.

The adult male, supposed to be ten years old, is thirty inches high at the shoulders, seventy inches in length from end of nose to base of tail, with a tail twelve inches long. His weight is about 420 pounds. The female is believed to be only three years old, and when received (1912) stood eighteen inches high at the shoulders, weighing 176 pounds. The Director of the New York park, Dr. William T. Hornaday, describes them in the Zoological Society Bulletin (July, 1912) as follows:

"The Pygmy Hippo is characterized first of all by its midget size, which in the adult animal is about equal to that of a twelve-months-old baby hippo of the large species. Its skull is more convex, or rounded, on its upper surface, than that of *H. amphibius;* its legs are longer and more slender in proportion, and its eyes do not "pop" out of its head like those of the giant species. Another striking character is the long tail, which in proportion is about twice as long as that of its only living relative, *amphibius*.

"The face of the Pygmy is relatively

[2] The principal references are Proceedings of the Phila. Acad. Sci., Morton in 1844 and 1849, Leidy in 1852; and Zoo. Soc. Bull., N. Y., Hornaday and Schomburgck, xvi, 877, July, 1912.

smaller than that of the large species, which brings the eyes nearer to the median line of the skull. The lower jaw of the Pygmy bears only two incisor teeth, while the large species has four; and while the orbits of *liberiensis* are large, they are proportionally less elevated than those of the large hippo. As the latter swims nearly submerged, the eyes seem to float on the surface of the water like two shiny glass marbles.

"The color of the Pygmy is *recorded* as 'slaty black' on the back, sides greenish slaty gray, and under parts grayish white.

NOT TRULY AMPHIBIAN.

"We await with keen interest Hans Schomburgck's account of the habits, and life history in general, of this rare and strange animal. We have been informed, however, that it makes its home in swamps and wet forests, often at a distance of several miles from the nearest river or lake, and that it is not at all dependent upon large bodies of water, as its colossal relative always seems to be. We may confidently expect to hear that it subsists on fleshy and tender plants and reeds, and grass that is not too coarse and tough to be masticated by small jaws."

In the same issue of the Bulletin, the capture of these animals is described by Hans Schomburgck, Major and Military Attache of the Liberian Legation at London, who spent a year in Liberia securing these hippopotami for Carl Hagenbeck. His story forms an interesting chapter in the romance of zoological and botanical exploration.

"The greatest difficulty in hunting the Liberian Hippopotamus," he says, "is that, unlike their big cousins, they do not frequent the rivers. They make their home deep in the inhospitable forest, in the dense vegetation, on the banks of the small forest streams; but, not satisfied with the protection the forest affords them, they enlarge the hollows which the water has washed out under the banks, and in these tunnels, where they are invisible from the bank, they sleep during the heat of the day.

ANIMALS CAUGHT IN PITS.

"In spite of all difficulties, however, I had not given up the idea of catching a hippo alive. Wherever I found a likely place I had a pit dug. It is easy to catch the great East African Hippo, which keeps continually in the same water and uses the same tracks. With the Pygmy Hippo, it is very hard even to find a place where there is the slightest chance of catching one, because this brute roams through the forest like an elephant or a pig, mostly goes singly, though sometimes in pairs, and rarely uses the same track twice.

"Meanwhile over a hundred pits had been made by my men, all carefully dug seven feet deep and covered so that not the sharpest eye could detect any sign of danger.

"At last, two days after I shot my first animal, and when I was still working on its thick skin, a boy rushed to my tent breathlessly shouting from afar:

"'Massa! Massa! Dem Mwe done catch!'

"On Nea Tindoa, an inhabited island in the Lofa river, a big bull had fallen into one of my pits. My sergeant, Momoro, started at once with a few boys, to reach the place the same night, and keep guard to prevent the meat-hungry natives from killing the Hippo.

"At last I had succeeded! Against the prophecies of Europeans, Liberians and natives! And only a few days before, Tawe Dadwe told me: 'It is impossible to catch a Mwe![3] It has never been done, and they have only been shot after they have been caught in the pits. They are too dangerous. Many a hunter has been killed. You white men know a lot, but here you are trying something that is impossible.'

ANIMALS EASILY HANDLED.

"Early the next morning I reached the place. Before night a fence had been built around the hole, and the animal was let out. It was a beautiful full-grown bull, in the prime of his life.

"Nothing succeeds like success! Six days after that, the second one was

[3] The native name of the hippopotamus. By English-speaking natives it is usually called the Bush-cow or Bush-pig. It is so different from the larger hippopotamus that some zoologists have created it a distinct genus for it.

caught; this time a two-year-old cow. A week later, the third, a young three-quarter-grown bull was taken."

The difficulties of transport to the coast, and thence to Europe, were great, but the animals stood them well, and apparently are not troubled by small discomforts or bothered by over-sensitive nervous organization. There is every reason to suppose that they would be adapted to semi-domestication in the swamps of the south, unless the supply of food in winter proved too small for their needs. Such a question can only be tested by actual experiment. In case they proved unable to live comfortably on the roots which they could grub up during the colder months, it might be entirely practicable to pen them up and feed them.

As to their hardiness in the open air in the gulf states during winter, there is no evidence, but it need not be presumed that because they come from a tropical country, they could not adapt themselves to the southern United States. Many of the domestic animals in the temperate zone are of strictly tropical origin.

At present the cost of breeding animals is prohibitive, the New York Zoological Society having paid $12,000 for three, but if this difficulty is overcome, animal breeders will have an opportunity to try an experiment that will be as certainly interesting as it will be probably important.

P. B. P.

The Control of Heredity

Natural selection and the survival of the fittest will not of themselves perform miracles of regeneration. They represent the method followed by the workings of heredity. Where the human race is concerned, men have now the power consciously to direct them into barren or profitable channels. The whole fate of civilization hangs on the question of whether this mighty engine of construction or destruction is to be used for good or evil.—W. C. D. and C. D. Whetham: Heredity and Society (1912).

The Influence of Environment

I will not dogmatically assert that environment matters not at all; phases of it may be discovered which produce more effect than any which we have yet been able to deal with. But I think it quite safe to say that the influence of environment is not one-fifth that of heredity, and quite possibly not one-tenth of it. There is no real comparison between nature and nurture; it is essentially the man who makes his environment, and not the environment which makes the man.—Karl Pearson: Nature and Nurture (1910).

PRENATAL INFLUENCES

What We Know of Them Gives No Ground for Making Them a Basis of Eugenic Teaching—Propaganda Must Be Kept on Absolutely Sound Scientific Basis Unless It Is to Result in More Harm Than Good.

David Starr Jordan,
Chancellor of Leland Stanford Junior University, California.

IT HAS been said that "the transmission of the sacred torch of heredity undimmed to future generations is the most precious of all worths or values in the world."

Accepting this statement from some unknown writer as a substantial fact, we may derive from it the enormous value to the world of all facts which bear on the question of Eugenics, the art by which sound parentage may be granted to the next generation. Every fact relating to human heredity is a precious fact. The aim of the Eugenics movement is to make these facts matters of common knowledge as the multiplication table is. This requires a great deal of time and practice. It is the work of teachers, and its methods should be methods of science, not of emotion.

Because the facts of Eugenics are so incalculably precious, it is necessary that their purity be guarded. To mix up what scientific men really know with what emotional people vaguely guess is to destroy the value of the whole. There are a great many things about heredity and inheritance yet to be discovered. There are many questions to which we do not know the answer until we find it out.

Many of these relate to the relation of external conditions, maternal impressions and the like, to the unborn child. The occasion of writing these lines is the reception of a number of a journal which, with the best of intentions, "holds as chief of the means to be used the power of the parents to determine pre-natally the character of their children."

In other words, it places above actual knowledge of actual fact, a piece of spurious science, partly based on old wives' tales and partly on disconnected facts connected with the wholesomeness of clean living.

"MATERNAL IMPRESSIONS."

What can parents do to determine before birth the character of the child? Nothing, so far as we know, except so to live that the germ cells are not enfeebled, and the foetus checked in its period of quiet nutrition. Most of the stories of prenatal influences are pure fables. No child was ever born with a dog's face, because its mother was scared by a dog. No child ever acquired gift of song, because its mother yearned for music, nor because she saturated her life with melody. The child may be harmed, no doubt, by all kinds of unsanitary life, by hysteria most likely as well as by drugs. But the injury is not rendered in kind—so much liquor, so much tendency to drink—but in reducing as it were the momentum of child life.

The experiments of Dr. Charles R. Stockard and others have shown that germ cells may be actually weakened or destroyed by the use of alcohol. Presumably defective germs would mean defective growth, a matter not of heredity but of development. Apparently many cases of mental and physical distortion have their origin in alcoholic deterioration of germ cells. This line of study opens a large field in which no very great progress has yet been made. It does only mischief to assume that we

know what we only hope or fear that we may sometime know.

There is no question of the transmission of Syphilis from parent to child, for the minute animal organism, Spirochaeta, which produces the disorganization of tissues known as Syphilis, flows with the blood. In like manner, the plant organism, Gonococcus, may be implanted in children, most of those born blind receiving their affliction at birth in the tender membranes of the eyelids.

STORIES INCREDIBLE.

But taking current stories, it is scientifically incredible that Jessie Pomeroy became a murderer because her mother went with the lunch basket to the butcher's shop. How medicines unsuccessfully intended to produce abortion may affect the unborn foetus is a matter about which we know very little and we may condemn the abominable practice itself while admitting that the resultant mischief is beyond our calculation. The "lady," who confessed that the destructive disposition of her little boy was "inherited from her own desperate efforts to rid herself of him before birth," is not a competent judge of the relations of cause and effect. More likely the boy was bad through inheritance of traits of a bad mother, and we have no right to assume that it was her vicious action, not her vicious temper, that left their stamp on the boy's heredity. But it is still more likely that the story itself is a pious invention, told for the sake of the moral it teaches.

It is asserted, in connection with this story, that "common people are kept in ignorance of the causes which produce human monsters." Learned men are also often ignorant in these matters, until little by little they slowly find out the truth, and this truth in general is, "Like the Seed is the Harvest." Clean, wholesome men and women lead clean and wholesome lives. Such people create children from sound and potent germ cells, and to foster this condition is the function of eugenics. Lapses from sound living are usually traits of people of unsound character. Unwholesome traits exist in everyone, and sometimes these are transmitted or exaggerated in the children.

A MODIFICATION FOR WORSE.

A child is a mosaic of parental and atavistic traits, one fourth, on the average, from each parent, others from characters latent in the parent but going farther back. We know of no way by which we can foretell the combination or modify it for the better by any line of action. We may modify it for the worse by intemperance, worry, disease and in ways which prevent normal development or normal nutrition.

To have really good children, the parents must be of good stock themselves. Bad fruit is borne mainly by bad trees, and the inheritance of badness springs from inherent tendencies or perversities, just as strong in heredity where they are latent as where they have been actually called into action. It must not be forgotten that strong characters are not those without temptation to evil, but those in which the better elements are triumphant.

Besides the myths of prenatal influence, we have also a series of myths, more scientific in aspect, but equally unfounded, under the name of Telegony. The first mate of a female animal is supposed under this theory to affect or infect all her future progeny. This idea is probably without any scientific foundation either in man or beasts. It is based on a misinterpretation of a single experiment. A mare once mated to a zebra, bore afterwards to a horse father a colt with traces of dark bars or stripes. But such bars occur among horses not suspected of zebra parentage. The original horse as a wild animal was probably marked by dark stripes. In the little Journal which suggested these remarks, we read, "Ignorance is a fruitful source of wrong in matters of sex, hence the importance of pure knowledge for all." This is all well stated. It needs the further insistence that *no knowledge is pure unless it is true*, and to be true it must be free from all guess work, sentimentalism or hysteria.

VARIATION IN TOBACCO

Change of Environment Seems not to Cause Breaking Up of Types—Crossing the Only Means of Producing New Types—For Commercial Breeding, However, Both Heredity and Environment Must Be Taken into Consideration.

H. K. Hayes

Plant Breeder, Connecticut Agricultural Experiment Station, New Haven, Conn.

In recent years many foreign types of tobacco have been grown from imported seed in the United States. In most cases these have proved very variable in their characters during the early years of their development, and this has led to a common belief that a breaking up of type is caused by the change of environment when seed of southern tobacco is grown in the north.

Shamel[1], in a brief review of some of the phases of tobacco breeding work, says: "The writer believes that the two efficient means of inducing variability as a source of new types are change of environment and crossing. So far as the writer is concerned the change of environment—usually the growing of southern seed in the north—is the most effective means of inducing variability."

A recent article by Hasselbring[2] on Cuban tobaccos gives a logical reason for the diversity of types which are found when Cuban seed is grown in the United States. This writer shows that there are many types of tobacco in Cuba. As the seed is saved from suckers which grow from the base of the old roots and as these suckers do not show the characteristics of the parent plants, no attempts at seed selection have been made. Furthermore, as the seedlings are generally grown in the mountains and sold to growers in all parts of the island this diversity of types is constantly maintained.

Hasselbring also presents data on a number of pure lines which were grown both in Cuba and in Michigan, and shows that in these pure lines no breaking up of type occurred and that whatever modifications did appear due to the change of environment, appeared alike in all of the plants of a given strain.

In 1908 the writer became interested in the study of heredity in tobacco and has had many opportunities to observe the effects of environment on tobacco characters. The results of these observations serve to corroborate the belief that environment does not cause a breaking up of type.

CUBAN VARIETIES USED.

In 1910 an experiment was begun to determine how many years of selection were necessary to develop a type similar to the present Cuban shade variety. During this season about one hundred and fifty plants were grown at the Windsor Tobacco Growers' Corporation in Bloomfield from seed sent from Cuba to the plantation manager, J. B. Stewart. This original seed was given a selection number, 13. The variability this first year was very large and only five or six of the one hundred and fifty plants gave promise of commercial value. Selfed

[1] Shamel, A. D. Tobacco Breeding Amer. Breeders Report, Vol. 6: 268-275, 1910.

[2] Hasselbring, H. Types of Cuban Tobbacco. The Botanical Gazette, Vol. 53; 113-126, 1912.

CONNECTICUT HAVANA TOBACCO.

On the theory that a change of environment causes variation, Cuban tobacco grown from seed in Connecticut should show wide diversity. A carefully controlled test, however, convinces Mr. Hayes that the supposed variation does not appear, except as it may be the outcome of the mechanical and germinal mixture of characters. When the seeds from a single Cuban plant were sown in Connecticut, the row cultures had a very uniform growth, and the number of leaves was comparatively constant. (Figure 17.)

SUCCESSFUL PLANT BREEDING.

In order to produce a new strain of tobacco, the Connecticut Experiment Station crossed the Cuban Havana type, which has very large leaves but only a few of them, with the Sumatra type, which has numerous leaves, but only small ones. The offspring of this cross showed the characteristics of both parents in a blend, but in the following, or second filial (F_2) generation, the characters segregated, in accordance with the usual Mendelian procedure, so that some of the plants looked like the Havana grandparent and others like the Sumatra grandparent, as is shown in the other photographs illustrating this article. Among the forms produced by the cross were several that approximated the desired result, one of which is shown in figure 20. In the above illustration is the final result—the sought-for variety, which has been given the name of "Halladay Havana." It retains the large size of leaf of the Cuban Havana type to a marked degree, but, thanks to the infusion of Sumatra "blood" has more leaves than the Havana. Two distinct types of this variety are recognized, as shown in the above photograph, the one at the left bearing smooth, drooping leaves, and the one at the right erect, crinkly leaves. The photographs do not accurately represent the number of leaves borne by this new variety, however, for the reason that a first picking of five or six leaves has already been made from each one. (Figure 18.)

seed was saved from the two most desirable plants, which bore 19 and 20 leaves respectively. As a measure of variability the number of leaves per plant was noted and observations on general plant habit were also made. The two selfed plants were given the selection numbers 13-2 and 13-1, and their progeny was grown in 1911.

The variability was also large in the second season, 13-1 being as variable for leaf number as in the first year, but there was a much larger percentage of plants with good-sized leaves than in the original lot. In 13-2 there was a much larger percentage of desirable plants. Two plants of strain 13-2, bearing 18 and 19 leaves respectively, were self-fertilized and grown the following season. The plants in this third season proved very uniform both in the number and shape of leaves. As far as field characters go, these selections were the equal of the commercial Cuban tobaccos grown on the same field. The quality of the cured leaf was also very good, but no better than the present Connecticut Cuban shade variety.

Much variation was shown in the statistical results for number of leaves per plant. It is this variation that has caused the belief in the efficacy of environment as a means of inducing a breaking up in type. More recent knowledge of heredity convinces us that the apprent breaking up of type is simply an expression of the mechanical and germinal mixture of characters. Selection and inbreeding tend to produce homozygous forms, and the length of time necessary to obtain pure forms is largely dependent on the number of row cultures which may be grown,

CAREFUL TEST MADE.

To determine whether the variations observed in generations of the above experiment had a connection with change of environment, three seed pods picked from different plants growing in Cuba were carefully harvested and sent in separate compartments of a package from Cuba to Mr. Stewart. The seed from each pod was sown in sterilized soil, the seedlings being marked respectively C1, C2 and C3. A row of each of the selections was grown on the same land as the selections 13-2-3 and 13-2-4 previously mentioned.

Each of the row cultures had a very uniform habit of growth. C1 and C3 grew to about the same height, but the average size of leaves of C3 was somewhat larger than for C1. C2 had about the same average size of leaf as C3.

An examination of the results shows that C1 and C3 both produced about 21.3 leaves per plant and were not very variable for leaf number. It is possible that one 13-leaved plant of C3 really belonged to C2 and was accidentally mixed when sown. C2 only gave an average mean of 13.83 leaves per plant and a range of variation from 11 to 18 leaves. These selections show about the same variability, as determined by S. D. and C. V., as 13-2-3, 13-2-4 and the commercial Cuban, and indicate that there has been no breaking up of type due to changed environment.

In connection with a study of inheritance of separate characters of tobacco, some observations have been made on the effect of changed environmental conditions. While all quantitative characters are greatly dependent on environment for their full development, some characters are more noticeably affected than others. The most uniform character of all was found to be the number of leaves per plant. Each of four selections was grown both at Forest Hills, Mass., Bloomfield, Conn., and New Haven, Conn., from seeds of a single plant.

In order to have the counts as uniform as possible and yet allow the crop to be harvested, the following method was used. The number of leaves per plant was counted from the fourth leaf from the bottom to the leaf below the bald sucker at the top, "bald sucker" being the farm name for the first sucker which appears without true leaves. This method allowed the selections to be topped and also gave added interest, as the leaf counts represented about the average number of leaves which were harvested.

The field at Forest Hills was very fertile but in a region where tobacco

GRANDPARENT AND GRANDCHILD.

The Imported Sumatra type (shown at the left) was crossed with the markedly different Havana type (shown in the preceding cut). In the first generation there was a general blending of characters, which segregated in the second generation, so that a wide diversity of types resulted. The plant shown at the right is one of this second generation of the hybrid, in which the characters of the Imported Sumatra have so completely excluded those of the Havana type, that the grandchild can scarcely be distinguished from the pure Sumatra which was one of its grandparents. (Figure 19.)

SECOND GENERATION FROM CROSS.

This is another specimen of the second generation cross between Connecticut Havana and Imported Sumatra. It bore 30 leaves with short internodes, and was, therefore, a close approximation to the desired result, combining the large number of leaves of the Sumatra type with the large size of leaves of the Havana variety. Its contrast with the plant shown in the preceding plate, however, vividly shows the wide diversity of forms produced when segregation of characters takes place. (Figure 20.)

is never grown commercially. Bloomfield is in the center of the tobacco-growing region and the soil is perfectly adapted to it and heavily fertilized. The soil at New Haven is a poor gravelly loam, only moderately dressed with manure and chemicals.

The means of the different selections compared with the average mean show only a variation of 1.8 leaves per plant, and as only about one hundred and fifty plants were counted the results appear very uniform.

STANDARD DEVIATIONS.

As a measure of variability the standard deviations of the selections were calculated. A consideration of them shows the variation to be very uniform and little, if any, affected by different condition of environment. We may also add that these same selections have now been grown at the three different localities for two later generations without any evidence that environment very strongly modifies the number of leaves per plant.

Some observations have also been made upon the effects of different environments on plant height. Two selections were grown both at Bloomfield and in New Haven from seed of the same self-fertilized plants. These selections were very variable, due to the fact that they represent the second generation of a cross between two varieties. While difference in environment has very strongly modified the heights of plants, a consideration of the Standard Deviation convinces one that such modifications of this character as have appeared appear alike in all plants of a selection.

Although no statistical studies can be given showing the effects of environment on the same selection for leaf area, we have some observations on several pure lines of tobacco varieties grown under cultural conditions different from those under which the varieties are normally grown.

These are pure lines of a Connecticut Havana type grown under shade, of a small-leaved Sumatra type grown in the open, and a Broadleaf type grown on a poor sandy soil. By means of a planimeter the area of the bottom, middle and top leaves of one hundred and fifty plants of each of these pure lines was taken. Of course, the area of leaf is a character which is greatly modified by cultural and environmental conditions. The results, however, show about the same variability for the three pure lines given. Observations of these pure lines when growing showed no variation which could be considered as a breaking up of type.

VARIATION DUE TO CROSSING.

The study of the heredity of separate characters of tobacco shows that such characters as shape and size of leaf, size of stalk, and leaf number are in a large measure inherited independently. In brief, the results show that the first generation of a cross between two pure lines is of an intermediate nature in those characters by which the parents differ. In the second generation there is a segregation and recombination of characters and often new forms are produced. Some of the second generation forms breed true in the third generation, others breed true for some characters and are variable in the remainder, and others are as variable as the second generation itself. The length of time which it takes to produce a uniform type will depend largely on the number of varieties which can be grown in F2 and the number of row tests which can be grown in F3.

The general conclusions from this work are that environment is of great importance in any system of tobacco breeding, and quantitative characters and especially quality of cured leaf are in a large measure dependent on this feature. Change of environment, however, does not cause a breaking up of type, and whatever variations occur due to environment appear alike in all plants of a particular type.

Heredity is the second important factor, and poor types will give unfavorable results even under the best environmental conditions. Any system of tobacco breeding must take both heredity and environment into account.

The only known means of producing variability as a source of new types is by crossing. The number of new forms which will appear due to a particular cross will depend on the number of germinal characters by which the parent plants differ.

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MULTI-NIPPLED SHEEP AT BEINN BHREAGH, NOVA SCOTIA

Most breeds of domesticated sheep possess two nipples each, but the ancestral form was undoubtedly the bearer of a number of nipples, and "sports" are frequently found in flocks, which show rudimentary nipples in addition to the two functional ones. Starting with some of these sports, Dr. Bell has gradually bred up a herd of sheep possessing supernumerary mammae, in an experiment covering a quarter of a century. At present his flock contains no ewe with less than six functional nipples, and some of them have had eight. In addition to this goal, Dr. Bell simultaneously bred to increase the twinning habit of the ewes, so that they might produce more lambs to enjoy these supernumerary nipples. This attempt has also met with promising success as a family of sheep has appeared in the flock in which the ewes have twins more frequently and at an earlier age than ordinary ewes, and yield a sufficient supply of milk for the support of two lambs. (Frontispiece.) Photograph by Arthur G. Eldrege, published by "Country Life in America."

SEX-DETERMINATION IN SHEEP

Effect of Special Feeding on Ratio of Males to Females and on Fecundity of Ewes—First Result Nullified by Addition of Data from Following Years—Method of Handling the Multi-Nippled Sheep at Beinn Bhreagh.

Compiled by the Editor from the Records of Alexander Graham Bell, *Washington, D. C.*

SINCE 1889, Alexander Graham Bell has been engaged in sheep-raising on his farm of Beinn Bhreagh, near Baddeck, Nova Scotia, in order to fix a breed possessing supernumerary mammae, and exceeding the ordinary breeds in fecundity. In the course of this experiment (which, it may be mentioned, has been a complete success) he has had an exceptionally good opportunity to test the theory that the sex of offspring is dependent, in part at least, on the nourishment of the mother, and also to test another hypothesis suggested in the course of his experience—namely, that the degree of nourishment had an effect in favoring the production of twins—one of the objects for which he was working.

On April 17, 1901, Dr. Bell read a paper on "Conditions affecting the Fertility of Sheep and the Sex of their Offspring," before the National Academy of Sciences at Washington, in which he explained the circumstances which favored his investigation of this problem of the influence of nutrition on the sex of offspring, as follows:

"Foi some years past my shepherd, Mr. John McKillop, has attempted to record periodically the weights of the sheep entrusted to his care, for the reason that weight has been found to give a valuable indication of the general physical condition and health. Sheep, when suffering from serious illness, nearly always lose in weight—indeed loss of weight is commonly the first indication that anything is wrong. This fact has been utilized to guard the Beinn Bhreagh flock from infectious disease. When a sheep is found to be losing unduly in weight, it is separated from the others and given special attention.

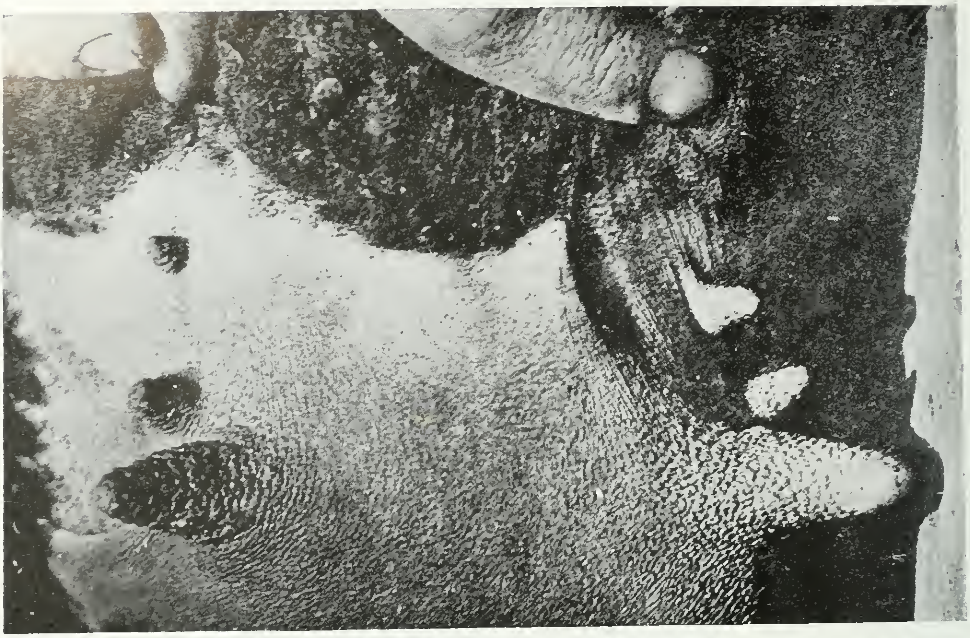
"In some cases these sheep have been found to be suffering from unsuspected diseases; in others unknown accidents had induced abscesses requiring surgical treatment. A decline in weight affecting a number of young lambs turned out to be due to the presence of tapeworm, and the lambs undoubtedly owed their lives to the timely discovery of the cause.

FLOCK WEIGHED FREQUENTLY.

"Experience having demonstrated that variations in weight are sometimes of great significance, the attempt was made to weigh the whole flock at least once a month.

"Unfortunately the summer and autumn records are imperfect, for it is not always easy or practicable to induce sheep to come and be weighed—especially when they are roaming about on a large pasture with plenty of cover. Still, a large enough number of records exist to enable us to ascertain the average weight of a Beinn Bhreagh ewe at the end of September, October, November, and December—thus covering the breeding season. Data were collected for this purpose in the summer of 1899 and the results show that the average weight increased rapidly up to the end of October. Beyond this point there was very little increase; and after the end of November there was an actual decline (which continued all winter under ordinary conditions of feeding).

"Thus, in Cape Breton Island, when mating occurs in October, the average ewe is improving rapidly in condition at the time of mating: When it occurs in November the weight is about the maximum, but increasing slowly: And when mating occurs in December the average



BELLY OF SIX-NIPPLED EWE.

In order to counteract the evil results of inbreeding, Dr. Bell has made it a habit to purchase all the multi-nippled sheep which he could find among his neighbors on Cape Breton Island. The photograph shows a ewe with six nipples, a natural "sport" which was found in a farmer's flock and added to the Beinn Bhreagh flock. (Figure 1.)

ewe is in failing condition, slowly losing weight from day to day."

As careful record was kept of the matings, and the births of lambs, this record was then compared with the weights of the ewes, at various times during the period of gestation. Dr. Bell's conclusion was that:

WHEN TWINS ARE BORN.

"Three conditions favorable to the productions of twins revealed themselves:—

1. *Maturity in the Ewes*—(Ewes four, five and six years old yielding a larger percentage of twins than younger or older ewes);
2. *Mating in October*—(With consequent lambing in March); and
3. *A rapid increase of weight at the time of mating with subsequent loss of weight.*

"The third condition seemed to be eminently susceptible of control; and in the autumn of 1899, the attempt was made to influence the weight by special feeding.

"Beginning in the latter part of September, 1899, each ewe was given a feed of oats twice a day in addition to the grass picked up on the pasture. After mating had been accomplished the extra feed was discontinued.

"It was expected that under this treatment the ewes generally would gain abnormally in weight up to the period of mating, after which the weight would gradually fall (on account of the discontinuance of the extra food) until the normal weight had been reached due to the natural condition of the pasture. The weight-curve characteristic of the twin-bearing ewes might thus perhaps be simulated; and the query arose:—Would the production of twins be increased?

"The whole flock was subjected to the experiment during the month of October, 1899, after which the extra feeding was discontinued with all. The experiment therefore was only complete

in the case of the ewes that were mated in October—the mothers of the 36 lambs born in March, 1900.

"The weight records show that the desired fluctuations of weight actually occurred, and occurred—not only with the twin-bearing ewes, but with the single-bearing as well.

"The fluctuations of weight seem to have been somewhat greater with the twin-bearing than the single-bearing ewes—which is consistent with former observations.

"Forty-five lambs were born in the spring of 1900; and of these, 16 or 36.6% were twins (eight pairs). This was a smaller percentage than in 1899, although above the average for the decade 1890-1899. Thirty-six of these lambs were born in March 1900—including all of the twins—16 in number or 44.4%: This percentage was less than the average for March lambs during the decade 1890-1899; but four of the single lambs were from two-year old mothers. If we deduct these we find that 32 lambs were born in March 1900 from ewes three years of age or older—16 single lambs and 16 twins (yielding the maximum percentage hitherto attained).

"On account of the small size of the flock, a very slight change in the absolute numbers would make a considerable change in the percentages."

The data, then, were not conclusive as to whether the extra feeding given the ewes in the fall of 1899 had caused them to produce a larger percentage of twins than ordinary. But, continues, Dr. Bell:

"While the effect upon productiveness was not well marked it would be premature to conclude that no effect at all had been produced by the special feeding; for no less than 72% of the March-born lambs were females—a circumstance quite unprecedented in the history of the flock.

"Of course the absolute numbers were small—only 36 March-born lambs in all (10 male and 26 female)—but the preponderance of females was too marked to be entirely accidental, more especially when we consider that the average of the flock for ten years showed males in excess.

"Both among twins and single lambs females predominated in March 1900. Five pairs of male and female twins were born in that month, and three pairs in which both twins were female:—Total eight pairs. No case occurred in which both twins were male. Thus—out of 16 twins, five were male and 11, or 68.75% were female. Out of 20 single lambs five were male, and 15 or 75% female.

"If climatic conditions were involved, or general causes of any kind affecting the whole Island of Cape Breton, it seemed reasonable to suppose that an unusual proportion of female lambs would be found in the Island generally in the spring of 1900.

"My shepherd, Mr. John McKillop, and Mr. Angus McInnis, of Beinn Bhreagh, undertook an investigation of this point; and, in May, 1900, they collected statistics from the neighboring farmers concerning the number of male and female lambs born that Spring. Thirty-two flocks were examined, containing 371 lambs,—202 of these were males and 169 females.

"In four flocks the males and females were equally divided. In 14 flocks males were in excess, and in 14 flocks females. The summation of the whole shows a majority of males (54.4%):—The large female percentage upon Beinn Bhreagh was evidently, therefore, a local matter.

"In flock No. 23, belonging to Mr. Farquhar Macrae, an unusual proportion of male births occurred. Out of 26 lambs born upon his place no less than 23 (or 88.5%) were males, and only three (or 11.5%) were females.

"This fact led to a special investigaiton of the treatment of his flock during the preceding year (1899). It was found that in the autumn of 1899 the ewes were roaming at large upon an upland pasture, unaccompanied by males, until the middle of November, when the ram was released and allowed to run with the flock. The sheep received no care until starvation drove them to the barn, in the middle of January, 1900, after which they were given a daily ration of dry hay. In this case, then, mating occurred late in November, or early in

December, 1899, at a time when the ewes were beginning to lose weight on account of failing pasture—after which they remained in reduced condition until their lambs were born. Under these circumstances 88.5% of the lambs were males; whereas in the Beinn Bhreagh flock, where the ewes had been specially fed, 72.2% were females (of the March-born lambs).

"These facts seem to indicate that perhaps, after all, the special feeding in the autumn of 1899, may have been responsible for the large proportion of females born in 1900.

DIFFERENCES IN WEIGHT.

"If the nutrition of the mother during the early period of gestation is an element in determining the sex of her offspring, we may reasonably hope to observe some characteristic differences of weight between the mothers of males and the mothers of females at this period. The records of the Beinn Bhreagh flock are sufficiently voluminous to enable us to examine this point.

"An inspection of the figures shows that the differences of weight are slight, but, on account of the considerable numbers involved it may well be that they are significant. At the beginning of October, before mating had been accomplished, the average weights of the two classes of ewes (male-bearing and female-bearing) were the same.

"The average male-bearing ewe increased in weight up to the end of October, after which there was a decline: The average female-bearing ewe, on the other hand, continued to gain in weight all through November so that by the end of that month the average female-bearing ewe outweighed the male-bearing—a superiority retained during the subsequent decline.

"Such being the results in the case of matings during the decade 1890-1899, we added the data for the lambs born in March 1900, from matings which occurred in October, 1899. In all these cases the mothers were specially fed, as described above, up to the time of mating.

"Here again we observe a reversal in the relative weights of the two classes of ewes. The male-bearing ewes, on the average, outweighed the others at the beginning of the period of gestation, but after mating lost weight so much more rapidly than the female-bearing ewes that the latter soon became the heavier.

MOTHERS OF TWINS HEAVIER.

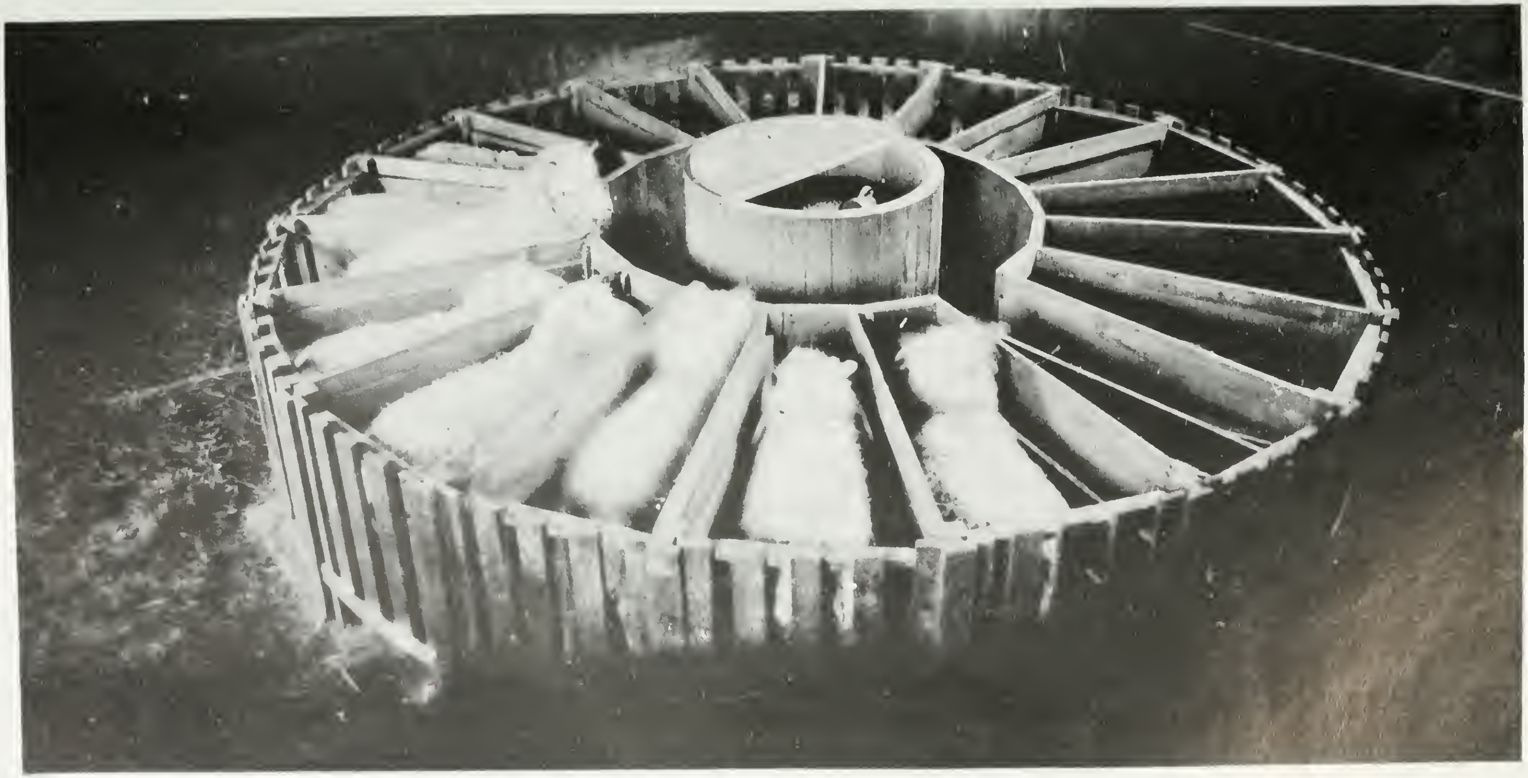
"In order to afford data for more detailed examination of changes of weight, these ewes were weighed once a week during the whole period of gestation. We found that the mothers of twins were above the average of the flock in weight; and the mothers of single lambs were below the average.

"Among the single-bearing ewes the mothers of males averaged less in weight than the mothers of females. It was noticed that the mothers of males were losing in weight at the time of mating, and immediately after mating, whereas the mothers of females substantially retained their weight for some time after mating.

"Among the twin-bearing ewes there were none who had male lambs exclusively. Those who had male as well as female lambs were losing in weight at the time of mating and immediately after; whereas those who had female lambs alone were increasing in weight at the time of mating, and, though the weight dropped afterwards, did not continue to drop but remained substantially on a level for several weeks. Those who had twins, male as well as female, were nearly 12 pounds heavier than those who had twin females alone, at the beginning of the period of gestation; but subsequently lost weight so rapidly that seven weeks after mating they had lost their superiority in this regard.

"All these ewes were given a special feed of oats twice a day up to the time of mating, after which the extra feed was discontinued, the ewes then deriving their sole nourishment from the pasture.

"The aggregate and average weekly weights, in the autumn and winter of 1899, of the 20 ewes who had single lambs in March, 1900, and of the eight ewes who had twin lambs, were also compiled, with similar results. Not only were the twin-bearing ewes very



FEEDING THE EXPERIMENTAL FLOCK OF SHEEP

In order that the gluttons might not have an advantage, and thus wreck an experiment based on the carefully ascertained weight of the sheep, each one was fed separately, so that he could get as much as he wanted. The sheep were weighed daily just before being fed, and from the fluctuations of weight it was thought that those ewes which bore female lambs were the heavier. The conclusions on which this belief was based were nullified by the addition of more data, however. It is not certain, either, whether any definite relation between changes of weight and the tendency to produce twins can be noted. (Fig. 2).

much heavier on the average than the single-bearing ewes, but their weight increased much more rapidly for some time after mating.

SIGNIFICANT DECLINE.

"We then calculated the aggregate and average weekly weights of the mothers of the 10 male lambs born in March, 1900, and of the mothers of the 26 female lambs born at the same time.

"The male-bearing ewes, on the average, weighed more than the female-bearing at the time of mating, but lost weight so much more rapidly after mating, that in a few weeks the female-bearing ewes were the heavier, a superiority afterwards retained throughout the whole period of gestation.

"The male-bearing ewes were losing in weight at the time of mating and immediately afterwards, in a much more marked degree than in the case of the female-bearing ewes.

"In the above calculations, the weights of the five ewes who had both male and female twins were included once among the mothers of male lambs, and once among the mothers of female lambs.

"A second computation was made, from which these ewes were excluded, so that it referred to ewes who had male lambs exclusively, or female lambs exclusively. It was found that the mothers of males averaged less in weight than the mothers of females; but the characteristic changes of weight at or about the time of mating are the same as noted before. The mothers of males were losing in weight at the time of mating; whereas the mothers of females retained their weight."

On the basis of these figures, Dr. Bell placed on record the following "Conclusion":

"It is to be regretted that the number of cases examined in this paper is too small to enable us to feel full confidence in the accuracy of the results, but the indications seem to point to the conclusion that variations of weight occurring at or about the time of mating may have great significance.

"They reflect changes in the condition of nutrition of the mother, at a critical period in the formation of the unborn young; and suggest the possibility of affecting the fertility of sheep, and controling the sex of their offspring, by suitable feeding for a short period of time before and after the time of mating."

INVESTIGATION RESUMED.

Such was the status of the investigation at the close of Dr. Bell's first ten years of work with this breed of sheep. He did not publish the paper abstracted above, however, but merely placed it on record among his own papers, making a note that "Some of the conclusions suggested were of so startling a character that it was thought better to await the collection of larger statistics before publishing the results."

In 1901 he returned to this subject, and on October 17 dictated a memorandum of the above results, continued by the following comment:

"These results have afforded some ground for the belief that there is a sensible difference in the weight changes of the mothers of male and female lambs about the latter part of October or the early part of November; and that loss of weight is associated with the production of male lambs; increase of weight at this time associated with the production of female lambs.

"I have always felt, however, that the absolute numbers involved were too small to give certainty to the averages and I still feel that we must wait for more numerous observations before announcing definite conclusions.

"It has occurred to me that by adding the lambs born 1900 and 1901 to those born during the decade 1890-1899, the absolute numbers involved would be increased, and the averages resulting therefore more certain."

The data made available in 1901 resulted from the birth of thirty-two lambs at Beinn Bhreagh, 14 male, and 18 female. The mothers of the 14 males weighed 1293 lbs. at the end of September, 1900; 1267 lbs. end of October; 1238 lbs. end of November; 1221 lbs. end of December; average weights 92.4 lbs. September; 90.7 lbs, October; 88.4 lbs. November; 87.2 lbs. December.

The mothers of the 18 female lambs weighed 1561 lbs. end of September, 1900; 1667 lbs. end of October; 1535 lbs. end of November; 1495 lbs. end of December. The average weights being: End of September 86.7 lbs.; October 92.6 lbs.; November 85.3 lbs; December 83.1 lbs.

Dr. Bell therefore prepared a table combining all the observations accessible from his records, as follows:

Weights of Mothers of Male Lambs

(Taken in Autumn preceding birth of lambs)

	September 30		*October 31*	
Date of Birth of Lambs	*No. of Cases.*	*Weights in lbs.*	*No. of Cases.*	*Weights in lbs.*
1890–1899	102	9029	108	10390
1900	10	1055	10	1105
1901	14	1293	14	1267
Total	126	11377	132	12762
Averages	....	90.3 lbs.	....	96.6 lbs.

	November 30		*December 31*	
Date of Birth of Lambs	*No. of Cases.*	*Weights in lbs.*	*No. of Cases.*	*Weights in lbs.*
1890–1899	120	11502	76	7227
1900	10	1023	10	957
1901	14	1238	14	1221
Total	144	13763	100	9405
Averages	....	95.6 lbs.	....	94.0 lbs.

Weights of Mothers of Female Lambs

	September 30		*October 31*	
Date of Birth of Lambs	*No. of Cases.*	*Weights in lbs.*	*No. of Cases.*	*Weights in lbs.*
1890–1899	81	7154	85	7948
1900	26	2680	26	2816
1901	18	1561	18	1667
Total	125	11395	129	12431
Averages	....	91.2 lbs.	....	96.4 lbs.

Weight of Mothers of Female Lambs (Continued).

Date of Birth of Lambs	November 30		December 31	
	No. of Cases.	Weights in lbs.	No. of Cases.	Weights in lbs.
1890–1899	99	9545	58	5553
1900	26	2727	26	2536
1901	18	1535	18	1495
Total	143	13807	102	9584
Averages	....	95.2 lbs.	....	94.0 lbs.

DIFFERENCE DISAPPEARS.

"The results," as he notes "are rather startling. It would be unnecessary to give a graphical diagram, for it is obvious from inspection of the tables that the average weights of the mothers of male and female lambs taken at the end of October, November and December, of the year preceding the birth of the lambs *were the same.* So that the two curves would be absolutely identical.

"What this means I do not yet know. The first impression made upon the mind is, that the former results were fallacious because based upon small numbers. In the above case the smallest number of cases used in determining an average is 100, so that the averages are surely more reliable than any yet obtained. It may be possible that significant variations in weight may occur within a period of two or three weeks, without affecting the *monthly averages.* If these significant variations occur chiefly in the month of October, this might account for the lower average weight of the male-bearing ewes at the end of September. The only difference that I can observe is this, that the male-bearing ewes increased in weight at a greater rate than the female-bearing ewes during the month of October. They started lower and reached the same point by the end of the month. The difference, however, is so slight that it may not be significant.

"The only way to ascertain whether there is any real difference in the average weights of the two classes of ewes (male-bearing and female-bearing) within a short period of time, two or three weeks, is to multiply observations at short intervals of time."

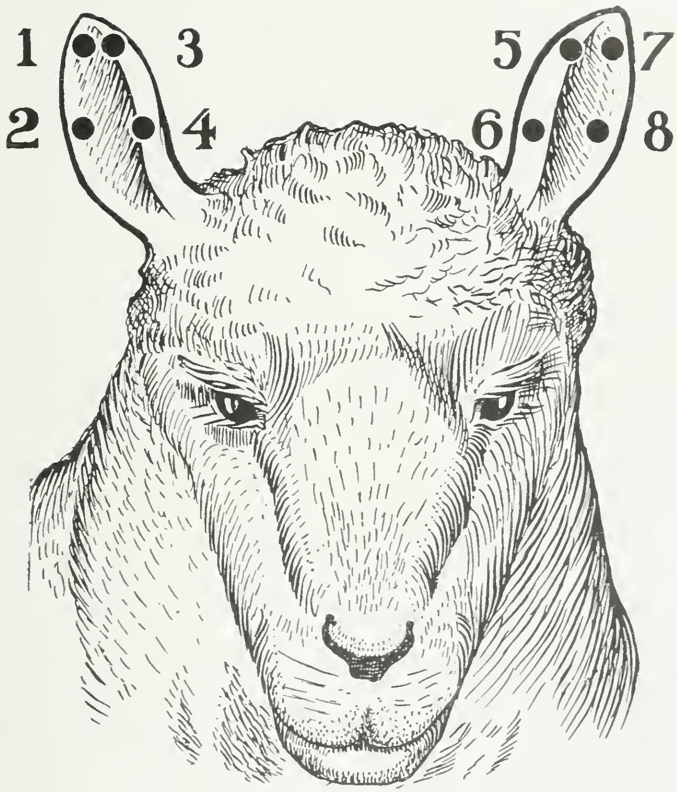
Having found the apparent result of the first calculation on determination of sex nullified by the addition of further data, Dr. Bell decided not to press the investigation of the influence of the same factor—special feeding—on the fecundity of the ewes, until he had larger figures on which to base his computations. On this point he noted:

"In order to examine the results as to twins I added together the weights of the mothers of lambs born during the decade 1890-1899, the year 1900, and the year 1901. A marked difference exists between the weight-curves for the two classes of ewes, twin-bearing, and single-bearing. In the case of the twin-bearing, however, the absolute numbers involved are too small to make me certain of my results, especially after the experience with the male and female-bearing. The maximum number of cases used in determining an average is only 88, and the minimum 50 cases. It would be well in this case also to have the average of at least 100 cases before announcing results."

HANDLING THE MULTI-NIPPLED SHEEP

Dr. Bell's final decision to publish the results of the investigation was due partly to the belief that his own experience might serve as an example of the danger of drawing conclusions in such studies from anything but a large mass of data. The report has high value, however, merely as a

record of a carefully conducted experiment on an exceedingly interesting and much debated subject, and in this connection an account of the methods of weighing and feeding the sheep which took part should be of interest. The following account is taken from a report to Dr. Bell under date of September 10, 1908, made by Mr. J. C. Davidson, fall experiments, I referred to the fact that feeding of the sheep collectively did not give justice to all sheep alike, as some sheep, like every other animal, are gluttonous when they are fed anything suitable to their taste, and I suggested that we feed all sheep individually; which would necessitate the building of a barn for that purpose.



SHEEP WITH EARS FULLY PUNCHED

By the use of all of the eight positions for punched holes, as shown in the diagram, 256 sheep can be identified. In small experimental herds, it is usually necessary to use only a part of the positions indicated. The sheep can easily be identified in the field, if the shepherd walks in front of them and attracts their attention; they then raise their ears, and the holes punched can be made out readily. (Fig. 2a.)

Superintendent of Beinn Bhreagh Nurseries, who has had charge of the flock for many years past:

"In former years it has been the custom every fall to do more or less extra feeding before or during the mating season. Hitherto this has all been done with the whole flock collectively. In the early part of the summer of 1907, discussing our arrangements for

"Having a good idea of the amount of time experimental work of any kind consumes, I planned the feeding pens in circular form with a large circular box in the center to hold the feed, as a labor saving device. This enables a man to feed the entire circuit of the pens, which hold 19 sheep at once, in practically less time than it would otherwise take to walk from the feed

room to the troughs in the ordinary way of feeding, besides having the great advantage of knowing that each animal, gets the same amount of feed placed in front of it; also if necessary, you know the exact amount each consumes, which might also be significant for various reasons. The individual feeding pens occupy the center of the building; on one end is a storeroom for feed, and on the other end is the weighing room; the latter also is an enormous time-saving device in comparison with the old method of having a weighing machine in every pasture enclosure.

FLOCK WEIGHED DAILY.

"A description of the daily handling of this experimental flock of multi-nippled sheep for a period of from ten to twelve weeks every fall may, to those who know the disposition of sheep,give some idea of the disadvantage this flock has in being disturbed at a time of the year when they would naturally be replenishing the lost energy they had sustained during the period of suckling their lambs.

"The sheep are collected from the pasture daily and taken to the barn-yard enclosures, and are driven into the weighing room,—or rather, if allowed, they rush—as after a day or two they know the performance as intelligently as their masters know it and become very anxious to get to this end of the building. The feed having already been put in the troughs of the different stalls, a man opens the door of the weighing box, and the sheep enter one at a time.

"Their ear marks, one, two, or three small punch holes, as the case may be, located in different positions in the ear, each hole at a given place, represent a figure from one to eight, which may also count twelve to eighteen or so on up into the hundreds. This is Dr. Bell's own invention of marking and does away with the use of collars or ear tags; and is also a sure means, to those familiar with the markings, of picking from large flocks any sheep that might get astray.

"The ear mark being called out, I examine same as a check. The ear mark number refers us to a different number which represents their register number. The sheep is weighed, weight recorded, and condition of wool or any irregularities noted. The door of the feeding stall being open in advance, a man opens the door on the side of weighing box and the sheep goes from weighing box to stall, door is closed and another opened, and by this time another sheep is weighed ready for next stall, where feed is consumed without disturbance and all share alike.

"It is very interesting to see how they keep their turns in going through the weighing machine, as after a few days the sheep that is weighed last, with few exceptions, will remain the last daily throughout the season; the whole performance passing off like clock-work. After coming from the feeding pens they are then visited by the male sex and any matings noted, which enables us to have an accurate record of father and mother, in every case. Besides, as the lambs come mostly in the cold month of March, we know when to look for them."

METHOD OF IDENTIFYING THE SHEEP

As the value of any experimental breeding with animals depends on an exact record of the individuals being kept, it becomes a matter of first importance to have a permanent and inalterable tag on each sheep. The ordinary tag fastened in the ear is easily torn out on wire fences, nor are collars wholly satisfactory.

After some experimenting, Dr. Bell devised a method of punch-marks in the lobes of the ears, which has proved quite satisfactory. Each lamb is marked before it is weaned, the ear being placed on a block of wood and an ordinary punch about one-fourth inch in diameter, with a hammer, used. The operation is all over before the lamb knows what is going on, and little pain is caused.

Dr. Bell described the operation, in a letter to a friend in 1910, as follows:

"Each ear of a sheep as it faces you presents two edges, an outer edge and an inner edge, on which holes can be punched in suitable positions to identify the sheep. As my flock is small, and simplicity is advisable, I do not find it necessary to distinguish more than two punch-places on the edge of the ear; one as high up as possible, the other as low down as possible. This gives us eight well marked places where holes can be punched. The shepherd is supplied with the accompanying diagram representing a sheep's head looking at him, and the punch-places are marked 1, 2, 3, 4, 5, 6, 7, and 8, as shown.

"Each sheep has a certain combination punched in the ears as an identifying mark. By punching only one hole in the proper place, we identify eight sheep. By punching two holes (for example, punch 1 and 2; 1 and 3; 1 and 4; 5 and 8; and so on) we can identify 28 sheep. By not limiting ourselves to any particular number of holes to be punched, we have the possibility of identifying 256 sheep. This being amply sufficient for any purpose, I have not found it necessary to distinguish more than two punch-places on the edge of each ear. I formerly tried three, one at the top, one at the bottom and one in the middle, but I found that my shepherd could not handle the system successfully, for it was often difficult to know whether a hole punched in the middle was intended to be above or below.

"For two years we have distinguished only two places on the edge of each ear. This has turned out to be perfectly satisfactory, for we can never mistake the upper hole for the lower, or vice versa.

"Given eight punch-places, as shown above, we can, by combinational punching, identify 256 sheep, as follows:

Total sheep identified by 0 hole	1
" " " " " 1 "	8
" " " " " 2 "	28
" " " " " 3 "	56
" " " " " 4 "	70
" " " " " 5 "	56
" " " " " 6 "	28
" " " " " 7 "	8
" " " " " 8 "	1
Total sheep identified by 8 holes or less	256

"For the purpose of identifying sheep that have lost their collars (I provide each sheep with a leather collar containing a metal plate riveted to it, bearing the name of the sheep), I have an index to the punch marks, and against the punch-mark I record the name of the sheep that bears that identifying mark. When a sheep dies, or is killed or sold, I scratch out the name of that sheep and give its punch-mark to another, so that during the two years that have elapsed since the adoption of the above system, I have only found it necessary to use 31 combinations out of a possible 256. I only mark these sheep that are kept; those that are to be sold are left unmarked."

In practice, this combination of punch marks is triplicated: that is, it is applied to white ewes, black ewes and rams, as there could be no possible confusion by having the same number used on both a white ewe and a black ewe. In this way, the number of positions which it is necessary to punch has been kept down. The use of collars on the sheep has now been abandoned, as the punch holes are found to meet every requirement of indentification.

LECTURER ON EUGENICS APPOINTED

A. Edward Hamilton of the Eugenics Record Office, Cold Spring Harbor, Long Island, N. Y., has been selected to serve in an educational capacity, and his services are available for lectures on eugenics before colleges, clubs, medical societies and other similar organizations. He is a graduate student of Clark University. Funds for this educational extension work were given to the Eugenics Record Office by Mrs. Huntington Wilson of Washington, D. C.

INJURIES TO GERM CELLS

Effects on Offspring of Intoxicating the Male Parent—Experiments Carried Through Several Generations Show that Results of Alcoholization are More Marked in Filial than in Parental Generation.

Abstract of an article in the American Naturalist by Dr. CHARLES R. STOCKARD, Cornell Medical College, New York City.[1]

Three years ago a series of experiments was begun with guinea-pigs in order to test the possibility of modifying the type of development in mammals, so as to produce definite monstrosities, as had been accomplished with lower vertebrates. This primary object has not been fully attained at the present time, yet the experiments have demonstrated several points concerning injury of the germ cells, and have shown that an alcoholized male guinea-pig almost invariably begets defective offspring even when mated with a vigorous normal female.

From the number of records available one might conclude that the effects of the alcoholic treatment were as pronounced upon the offspring of the second generation animals, although they had not been directly treated, as upon the offspring of alcoholized individuals. The poison injures the cells and tissues of the body, the germ cells as well as other cells, and the offspring derived from the weakened or affected germ cells have all of the cells of their bodies defective, both soma and germ, since each of the cells is a descendant of the injured germ cell combination. In this manner the defects or degenerate conditions are transmitted or passed to subsequent generations.

IN experiments to modify the germ cells of mammals the first proposition is to determine whether the substances used reach the germ cells directly. One of the best substances for such experiments is alcohol, since its action and distribution in the body have been largely studied and since it acts so decidedly to modify the developmental processes, as many workers have found on invertebrates, and as I have shown by treating fish eggs with this substance.

It is a well known and generally accepted fact that alcohol does cause changes and degeneration in many of the tissues of animals and man. The question arises, how, then, can the reproductive tissues, the ova and spermatozoa escape? Nicloux and Renault have found that alcohol has a decided affinity for the reproductive glands. In the testicular tissues and the seminal fluid an amount of alcohol is soon present which almost equals that in the blood of an individual having recently taken alcohol. The proportion of alcohol in the testis as compared with that in the blood was as two to three, and in the ovary of female mammals as three to five. From these observations it must follow that alcohol may act directly on the ripe spermatozoon shortly before it fertilizes the egg, and if this substance injuriously affects the germ cells. then one should expec to find an indication of he injury in the resulting development.

HUMAN CASES COMPLICATED.

There is an abundance of data bearing on the effects of parental poisoning on the human offspring, yet almost all of it is complicated. The question arises whether the defects of the offspring are actually due directly to the parental poisoning or to the often degenerate condition of the parent. With lower

[1] The detailed report of the experiment is in the American Naturalist, XLVII, Nov. 1913, from which this abstract is made.

HOW ALCOHOL STUNTS THE GROWTH

The guinea-pig at the left is a runt, because his father was alcoholic. He ought to weigh about 200 grams, but he weighs only 132. His mother was normal, and his degeneracy can, therefore, be traced with a good deal of certitude to the male parent. At the right is a guinea pig which, although only ten days older than the one at the left, is much larger in proportion, weighing 221 grams. His parents were both normal. (Fig. 3).

mammals this question may be controlled, since vigorous individuals with no physical weakness may be selected for study.

One of the most interesting human cases is that Forel cites as recorded by Schweighofer. A normal woman married a normal man and had three sound children. The husband died and the woman married a drunkard and gave birth to three other children; one of these became a drunkard; one had infantilism, while the third was a social degenerate and drunkard. The first two of these children contracted tuberculosis, which had never before been in the family. The woman married a third time and by this sober husband again produced sound children. This is a logical experiment,—the female was first tested with a normal male and gave normal children; when mated with an alcoholic male the progeny were defective. She was later tested again with a normal male and found to be capable of producing sound offspring. A number of such cases are on record but all are open to the question whether the defective offspring are actually due to the effects of the poison on the parent, or to the fact that the parent may have been weak and degenerate from the beginning.

ALL ANIMALS TESTED.

For our experiments to demonstrate the effects of alcoholization in guinea pigs, we take pains to select normal, healthy animals, and in all cases they are first tested by a normal mating in order to establish their ability to produce vigorous offspring. After such a test the treatments are begun. During the experiments the treated males and females are mated from time to time with normal animals, and in addition, control matings of normal individuals are made. Some of the specimens are treated with alcohol and ether. These substances were used since they readily act upon animal cells and since I had studied their effects on the development of fish embryos and found them to cause rather definite and easily recognizable defects in the central nervous system and organs of special sense.

In the beginning of the experiments alcohol was given along with the food, but the animals ate less and the food did not apparently agree with them. It was then administered in dilute form by a stomach tube; this method disturbed digestion and seemed to upset the animals considerably. It is certain that alcohol given to animals through the stomach deranges their digestion and appetite to such an extent that the experimenter is unable to determine whether the resulting effects are due to the alcohol, as such, or to the general deranged condition of the animal. When given in the drinking water they take little or none of the water and the treatment is insufficient. For these reasons an inhalation method of treatment has been resorted to which, as far as experience goes, has no serious disadvantages and does not complicate the conditions of the experiment.

METHOD OF INTOXICATION.

A fume tank of copper is made of sufficient size to supply breathing space for four or five guinea-pigs at one time. The tank is arranged with four outlets, so that definite amounts of the fumes may be passed through in a given time and the ventilation controlled. In this way each animal could be given about the same amount of the substances. The individuals, however, differ so in their resistance to the treatment that it has been found better to treat all to about the same degree of intoxication. This physiological index is more reliable as each animal is thus affected in a similar fashion each day. For this purpose they are placed in the fume tank on a wire screen, and absorbent cotton soaked with alcohol is placed beneath the screen, and the animals inhale the fumes.

Ether is given in a similar manner, except that the animals are much more readily overcome and must be carefully watched while inhaling even the most dilute doses.

In order to avoid handling the females during late pregnancy, a special treating cage is devised. An ordinary box-run with a covered nest in which the animal lives is connected by a drop-door with

a metal-lined tank, having a similar screen arrangement to that of the general treatment tank. The pregnant animal may be driven daily into the tank and thus treated with alcohol fumes throughout her pregnancy without being handled in any way that might disturb the developing fetus.

DIRECT EFFECTS OF TREATMENT.

Many of the animals have now been treated almost to the point of intoxication for six days per week for nearly three years. They are affected by the alcohol fumes in different ways; certain ones become drowsy and stupid, while others become excited and sometimes vicious during the treatment, constantly fighting and biting at others in the tank. One male always had to be treated alone on this account. The fumes are inhaled into the lungs and pass directly into the circulation, so that the animals show signs of intoxication very soon after being put into the tank, yet the intake of alcohol is so gradual that they may remain for one hour or more without becoming totally anesthetized. The mucosa of the respiratory tract is considerably irritated during the first few days or weeks of the treatment, but later becomes hardened and little effect can be noticed. The cornea of the eye is greatly irritated and often becomes milky white and opaque during the first few months; but later this clears up in most of the specimens and the animal is able to see perfectly, though one male that has been treated for 32 months is now entirely blind. The general condition of the animals under the treatment is very good; they all continue to grow if treated before reaching their full size, and become fat and vigorous, taking plenty of food and behaving in a normal manner in every particular.

Certain of the animals have been killed at different times during the experiment and their organs and tissues studied microscopically; all have seemed entirely normal. The tissues of one female were examined after she had been treated for over a year, and the heart, stomach, lungs, liver, kidney, etc., were all normal. She was generally fat but there was no fatty accumulation in the parenchyma of any of the organs except possibly a slight excess in the adrenal glands.

As mentioned above several of the animals, both males and females, have been partially castrated during the experiments and the ovaries and testis have been found to be in healthy condition.

The treated animals are, therefore, little changed or injured so far as their behavior and structure goes. Nevertheless, the effects of the treatment are most decidedly indicated by the type of offspring to which they give rise, whether they are mated together or with normal individuals.

The animals have been mated in various combinations. First, alcoholized males are paired with normal females, the paternal test, and also the crucial test of the influence of the treatment on the germ cells. Fifty-nine such matings have reached term. Twenty-five of these gave negative results or early abortions. Thirty-four of the fifty-nine matings resulted in conception which ran the full term. Eight, or about 24%, of these were stillborn litters containing in all 15 dead individuals. Many of them were somewhat premature. Twenty-six, or only 44%, of the matings produced litters of living young, containing a total of 54. Twenty-one, or almost 40%, of these young animals died within a few days or less than four weeks after birth and only 33 of them survived. Many of the 33 survivors are small excitable animals and though not treated themselves have usually given rise to defective offspring in the several cases where they have been mated with one another

WHEN FEMALE IS TREATED.

The second combination is between alcoholized females and normal males, the results of which are interesting in comparison with the above. In this combination there are two chances to injure the offspring; in the first place it may arise from a defective egg cell, or secondly, it may be injured by an abnormal developmental environment within the body of the alcoholized

TWO FOETUSES FROM A NORMAL MOTHER

The mother in this case was the offspring of a normal male and an alcoholized female. Although weak and small at birth, she finally developed normally. She was not treated with alcohol, but was mated to an alcoholized male. When she was accidentally killed, these two foetuses were found in her uterus—one 32 mm. long and the other 33 mm. The upper one has ill-formed hind legs, and a poorly developed posterior part of the body; the lower one is normal. It will be noted that all the affected offspring of alcoholic guinea pigs are weak in their hind extremities, and drag their legs; even to the point, as in this case, where the offspring of a normal mother is born deformed, through the influence of an alcoholic father and grand mother. (Fig. 4.)

female. Fifteen such matings have been made. Three of these, or 20%, gave negative results, or were possibly aborted very early. Three stillborn litters of nine individuals were produced. Sixty per cent. of the matings gave living litters, as against 44% in the first combination between treated males and normal females. The proportion of surviving young is, however less from the treated females than from the treated males. Of 19 living young nine died soon after birth and 10 survived.

BOTH PARENTS ALCOHOLIZED.

The third combination was between alcoholized males and females. Twenty-nine such matings gave in 15, or more than 50 per cent., of the cases negative results or early abortions. Three stillborn litters occurred, each consisting of two individuals. Only 11 living litters were produced containing 16 young, nine of which survived while seven died soon after birth.

All of the matings of the treated animals may be combined and compared with control matings as follows: In a total of 103 full term matings, 43, or almost 42%, have given negative results or early abortions, while 35 control matings failed in only two cases, or about 6%, to yield a full term litter. Fourteen, or 13½%, of the matings gave stillborn litters consisting of 30 dead individuals. Only one stillborn litter occurred in the 35 control matings; this was a large litter of four individuals and the mother seemed almost unable to carry them. The 103 matings gave only 46 living litters, about 45%, while 32 living litters, or 91½%, were pro-by the 35 control matings.

The 46 living litters from the alcoholic matings contained 89 young, 37 of which died shortly after birth and 52 survived. The 32 living litters from the normal animals consisted of 60 individuals only four of which died while 56, or 93 %, of them survived.

Of 119 full term young, living and stillborn litters, produced by the alcoholic animals only 52, or less than 44%, survived as against the 56, or 87½%, survivors among the 64 full term control offspring.

The offspring derived from the alcoholic individuals are termed second generation animals and were not themselves treated with alcohol. In three cases second generation individuals have been mated with normal and have given perfect results, although the litters have been small. It might seem as though the normal mate possessed a strong tendency to counteract any defect which may have been present in the second generation animal.

Mating second generation individuals with alcoholized guinea-pigs gave very different results. Two out of three such matings produced stillborn young, one of which was grossly deformed. The third mating gave two surviving young.

Nineteen matings have been made between second generation animals, the outcome of which compares very unfavorably with that from the control matings, while the data are closely similar to those obtained from the alcoholic matings. Seven, or almost 37%, of the matings gave negative results. Twelve living litters were born consisting of 19 individuals, six, or about 32%, of which died very soon after birth and showed various nervous disorders; one was entirely eyeless and decidedly deformed.

These are the initial experiments with mammals to show *that an injury of the germ cells may express its effect on the offspring and be passed through subsequent generations.*

A STRIKING CASE.

The actual outcome of the experiments may be more fully recognized by a consideration of one of the most striking cases. A large normal female, weighing about 700 grams, had given two normal young by a control mating and had since given non-viable young by a mating with an alcoholic male. She was then mated with another large strong alcoholic male which weighed 740 grams and which had given before this mating apparently healthy offspring by normal females. The mating resulted in the production of four young, all small and rather excitable in their behavior. These individuals from the normal mother and the alcoholized

father grew slowly, although they ate freely and appeared to be well. They remained small and below the average in weight. Three were males and one was a female.

One of the males was mated with a normal female and two normal young resulted. He was then mated with a female from an alcoholic father and she gave birth to two small young; one of these offspring was only half size and very excitable. He was then mated with a female from an alcoholic mother and one small young was produced.

A second one of the three males was mated with a normal female which produced one large apparently normal offspring. He was then mated with a female from an alcoholic father and two small young resulted, one of which died within five days and the other is weak and nervous. He was again mated with a normal female and one normal young was produced.

The third male was mated with his sister and she gave birth to three young. One of the young died when one day old, having been in a constant tremor since its birth; another lived for nine days but whenever it attempted to walk it was seized with spasmodic contractions; the third specimen exhibited the same nervous manifestations and was completely eyeless. This animal died eight days after birth and an examination of the brain showed an entire absence of optic tracts.

In the development of this animal it is probable that the optic vesicles were suppressed and never arose from the brain. Thus, no eyes, optic nerves, or optic tracts could have formed. This particular eyeless condition in these experiments is of interest since one is readily able to suppress the origin of the optic vesicles in fish and chicken embryos by similarly weakening the embryo with treatments of alcohol, ether, etc.

The mother of these offspring was remated with her brother, but she died six weeks later, not becoming pregnant. She was in an emaciated condition but had always been less than half normal weight.

The three extremely weak and defective offspring were doubtless due to the fact that both of their parents had similarly weakened or injured constitutions, having resulted from a single mating of a normal female with an alcoholized male. The eyeless offspring and the other two nervous non-viable individuals should not be interpreted as due merely to the fact that their parents were brother and sister. Several normal matings of brother and sister have been made during the experiment and perfectly healthy offspring have been produced. In the studies of heredity conducted on guinea-pigs brother and sister are crossed with impunity, in no way weakening their offspring. The significant point in the present consideration is that the two animals coming from the same mother and treated father may have had similar weaknesses or defects and the combination of two such individuals resulted in offspring which exhibited these defects to a more decided extent. The three animals were far more defective than their parents and owed their defects to the modified condition of the germ cells of the grandfather from which they descended.

PLANT BREEDING SECTION TO MEET

A meeting of the Plant Breeding Section of the American Genetic Association will be held on February 20 and 21, in connection with the National Corn Exposition at Dallas, Texas. It is open to all members of the association, and contributions will be welcomed. Those who wish to send or read papers should communicate the titles at once to C. P. Bull, secretary of the exposition, at Dallas, together with an estimate of the length. Other information can be secured from A. W. Gilbert of Cornell University, chairman of the research committee on plant breeding.

A STUDY OF SEMI-STERILITY

Hybrids with Half their Pollen and Ovules Sterile—Semi-Sterility Inherited in Half of the Second Generation—Progeny of Fertile Plants Remains Fertile—Progeny of Semi-Sterile Plants is Half Fertile and Half Semi-Sterile—A Demonstration of Gametic Segregation—A Theory of Semi-Sterility.

JOHN BELLING,
Florida Agricultural Experiment Station, Gainesville, Fla.

HYBRIDS between two allied species of plants are often partially sterile. In three hybrids I have completed an investigation of the exact degree of such sterility, and of the inheritance of such an exact degree of sterility in the succeeding generations. I have found what I regard as proof of the causing of a definite degree of sterility by the segregation of Mendelian factors among the pollen-grains and embryo-sacs, and the consequent *abortion of a definite percentage of these.*[1] The following brief description of the results may, I hope, be of use to plant breeders.

The plants crossed were species of Stizolobium. The Florida Velvet "bean" (*S. deeringianum*) was crossed (both ways) with the Lyon "bean" (*S. niveum*) a variety introduced from the Philippines, and the fifth filial generation (F5) has been grown. The Velvet bean was crossed with the Yokohama bean (*S. hassjoo*), and the second filial generation (F2) has been investigated. The Velvet bean was also crossed with the China (or Chinese) bean (*S. niveum* var.), of which cross only the first generation has yet been studied. Fig. 5 is a photograph of typical five seeded pods of the Velvet, Lyon, Yokohama, and China beans. When seeds are missing in these pods, this is usually due to the ovules dying before maturity, and not to the abortion of embryo-sacs.

FIRST GENERATION HYBRIDS.

The hybrid plants resulting from these crosses were *all* similar in one important respect, namely, semi-sterility. Though the pollen-grains of the four parent plants are, under normal conditions, all sound; though their ovules have normally perfect embryo-sacs; yet this was not the case in the F1 hybrids. The flowers of these hybrids had uniformly one-half of their pollen-grains quite empty and collapsed, and one-half of their ovules had *no* embryo-sacs. In the F1 hybrid of the Velvet by China, counts gave 3917 perfect pollen-grains to 3388 empty grains. Some of the empty grains are often hidden under the full ones, or swept to one side by the liquid in which the pollen is spread under the microscope, so that it is probable that the number of empty grains is larger than the actual count. Fig. 5a is a photograph of the pollen.

Counts of ovules in sections of 18 ovaries, from flowers of the same hybrid, gave 50 ovules with embryo-sacs, to 49 ovules with aborted embryo-sacs, proportions which were confirmed by examination of the pollen and ripe pods of the other hybrids. The empty pollen-grains were uniformly mixed

[1] Detlefsen's valuable investigation in American Breeders' Magazine, III. 4, pp. 261-5, of the inheritance of sterility in crosses and back-crosses between the guinea-pig and a wild Cavia, may, I think, be explained on the hypothesis of the segregation of factors among the spermatozoa, and the consequent abortion of those spermatozoa with certain factorial combinations; but I do not know whether this can be scientifically proved from the data.

WIDE GROUP OF BEANS EMPLOYED

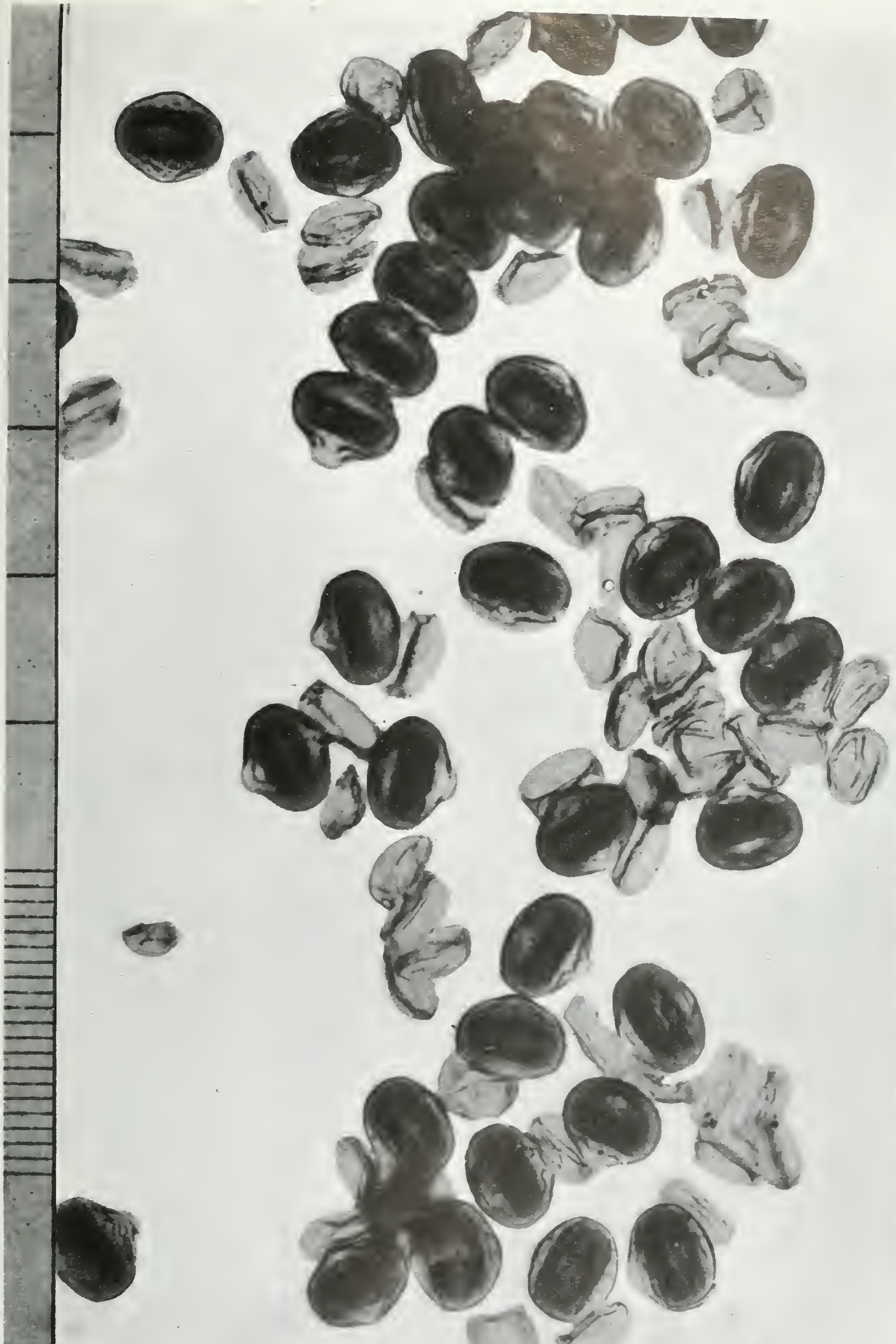
From left to right, the pods represent the ordinary Florida Velvet bean (*Stizolobium deeringianum*), the Lyon (*S.niveum*) a form which was introduced from the Philippines by the Department of Agriculture; the Yokohoma (*S.hassjoo*), a Japanese variety; and the China (*S.niveum* var.). The genus producing these "beans" is found in nearly every part of the tropics; its species can be divided into two groups—those which produce stinging hairs, and those which do not. The latter type is cultivated as a fodder, or to enrich the soil; its pods are eaten by the natives of India and other countries. (Fig. 5.)

with the full grains in the anther; and the sterile ovules were distributed at random in the ovaries. The ovary usually contains five or six ovules (rarely four or seven). A random distribution, such as would be caused by the segregation of Mendelian factors, and by no other cause known to me, would give for five ovules, (counting from the tip of the ovary) and 18 ovaries:

	Sterile	Fertile	Calculated	Found
No. of ovaries with........................	5	0 ovules	0.6	1
....	4	1	2.8	1
....	3	2	5.6	7
....	2	3	5.6	5
....	1	4	2.8	4
....	0	5	0.6	0

A random distribution would give equal numbers of fertile and sterile ovules for each position in the pod, counting from the tip. The actual numbers are:

	1st.	2nd.	3rd.	4th	5th.	6th.
Fertile....................	12	9	10	6	9	4
Sterile....................	6	9	8	12	9	5



POLLEN GRAINS OF SEMI-STERILE PLANT.

This remarkable photo-micrograph of pollen grains of a first generation Lyon x Velvet hybrid shows strikingly the nature of the sterility, half of the sacs being empty. It was made by staining the pollen yellow and then photographing it with blue glass on the condenser. The size of the grains can be accurately measured by the scale at the side of the photograph, which is graduated in tenths and hundredths of millimeters. (Figure 5a.)

THREE FIRST-GENERATION HYBRIDS

From left to right the pods represent the results of crosses of Lyon by Velvet, Velvet by Yokohama, and Velvet by China, respectively. It is easily seen that these pods contain only half the normal number of seeds—that is, they are semi-sterile, in spite of the fact that all the pollen grains of their parents are normally sound and their ovules have normally perfect embryo-sacs. In the hybrids shown above, the semi-sterility is found, by microscopical examination, to result in one-half of their pollen grains being empty and collapsed, and one-half of their ovules being destitute of embryo-sacs. (Fig. 6).

The agreement is as near as is to be expected with only 18 ovaries.

The sterile ovules do not grow in size, and the place where they are can usually be seen as a constriction from the outside of the pod. On opening the ripe pod, the aborted ovules are seen as blackish specks, less than one millimeter across. It is rare to find pods containing as many as five or six *seeds* in the hybrid (F1) plants, though this is a usual number in the parents. The seeds in the hybrid pods are as well formed, and germinate as readily as those of the parent plants.

Fig. 6 shows three selected pods of the Lyon by Velvet, the Velvet by Yokohama, and the Velvet by China, first-generation hybrids. Only about one or two per cent of the pods of these hybrids have no aborted ovules; some pods have several aborted ovules, some have few, but the commonest numbers are two or three. I have usually chosen pods for illustration in which aborted ovules alternate with seeds, but it is as common to find two aborted ovules or two seeds contiguous.

Fig. 7 (left) depicts pods of the Velvet, Yokohama, and their first-generation hybrid. Three aborted ovules can be seen in the hybrid pod.

Fig. 7 (right) illustrates pods of the Velvet, China, and their first-generation hybrid. The positions of two aborted ovules are visible in the hybrid pod.

TWO FIRST-GENERATION HYBRIDS AND THEIR PARENTS

Two species of beans, each bearing pods normally containing five to six seeds, are crossed. The resulting plants bear pods containing not five to six seeds, but only half that many. This is a phenomenon familiar to geneticists, and represents one phase of one of the great problems of genetics—sterility. Mr. Belling thinks that the laws underlying the phenomenon can be studied to better advantage in these species of Stizolobium than in most plants, or any animals, and he has been working with large numbers of them to determine the arithmetical quantities involved. In the above photographs of two results, with a millimeter scale, the opened pods at the left are (from above downward) Velvet Yokohama and their first-generation hybrid. At the right again from the top downward, are opened pods of Velvet, China, and their first generation hybrid. In the hybrid at the lower left, the positions of three aborted ovules can be seen, while in the one at the lower right the positions of two aborted ovules are plainly visible between the seeds. The seeds which grow at all are as well-formed, and germinate as readily, as those of the parent plants, but the sterile ovules, making up half of the total number (on the average) are found, on opening the pod, to be nothing but blackish specks, less than one millimeter wide. (Fig 7.)

SEMI-STERILITY IN THE SECOND GENERATION

At the left are four typical, five-seeded pods from four fertile plants with normal pollen, from the second generation of Velvet by Yokohoma. The four pods on the right are taken from four other plants of the same generation and cross, but are all only half-filled with seeds. It will be remembered that, while in the first generation all the pods were semi-sterile, in this second generation half of the plants develop full pods like those at the left, while the other half of the plants are again semi-sterile, with the result shown in the four pods on the right, where half of the ovules will be found, on opening the pods, to be aborted. These last four plants had semi-sterile pollen. (Fig. 8).

THIRD GENERATION FROM FERTILE PARENT

This photograph represents pods from six plants of the Lyon and Velvet third generation (F3), grown from seed of a wholly fertile F2 plant, which was in turn grown from the seed of a semi-sterile F1 plant (all of the F1 generation being semi-sterile, of course). The above pods may fairly be taken to stand for the produce of half of all the plants of the third generation: they all have normal pollen and ovules, because they were produced by a F2 plant which was fertile. In each generation, fertile plants give rise to fertile plants; semi-sterile plants give rise to plants which are half fertile and half semi-sterile. (Fig. 9).

SECOND FILIAL GENERATION.

In the second generation (F2) half the plants have perfect pollen-grains, and the other half have a mixture of equal numbers of full and empty grains in *all* their flowers. The plants with perfect pollen have also perfect ovules; the plants with semi-sterile pollen have also half their ovules sterile. In the F2 generation of the Velvet-Yokohama cross, which was thoroughly investigated, there were 180 fertile plants and 195 semi-sterile plants. Counts of the numbers of seeds in the pods of the second-generation plants of Velvet by Lyon and Lyon by Velvet confirm this ratio of 1:1.

Fig. 8 (left) shows typical five-seeded pods of four fertile plants with normal pollen from the second generation of the Velvet by Yokohama cross. It will be remembered that half of the plants of this generation were normal, and half were semi-sterile.

Fig. 8 (right) shows selected pods of four fraternal plants of the same cross and generation as the plants whose pods are shown in Fig. 8 (left). These four plants, however, had semi-sterile pollen.

THE THIRD GENERATION.

In the third generation (F3) *all* the descendants of fertile plants have good pollen and ovules; but the progeny of the semi-sterile plants again separates into equal numbers of fertile and semi-sterile plants. In the F3 generation of the Lyon by Velvet cross, which was thoroughly investigated, the progeny of 14 fertile plants amounted to 264 plants, all with good pollen and ovules;

THIRD GENERATION FROM SEMI-STERILE PARENT

The opposite cut showed the product of fertile F2 plants; this one shows the product of semi-sterile F2 plants, in the same cross, Philippine Lyon by Florida Velvet. The plants which bore the above pods are first-cousins of the ones which bore the pods on the preceding page. These were all the product of one semi-sterile F2 plant, which was in itself the product of the usual semi-sterile F1 plant. As is evident, half of these plants bore pods, represented by the three at the left, which contain the full complement of beans; the other half of the plants produced pods typified by the three at the right, which are again semi-sterile, and contain only half as many seeds as they would have, if all their ovules were properly developed. The first three of these plants had normal pollen; the second three had semi-sterile pollen. (Fig. 10).

the progeny of seven semi-sterile plants consisted of 106 fertile plants and 102 plants with semi-sterility of pollen and ovules.

Fig. 9 is a photograph of pods of six third-generation plants. These belonged to the family of one fertile second-generation plant. All had normal pollen. They descended from the Lyon by Velvet cross.

Fig. 10 (to be compared with Fig. 9) gives the pods from six third-generation plants (first cousins to those in Fig. 9). These belonged to the family of one semi-sterile second-generation plant. The first three had normal pollen, the last three had semi-sterile pollen.

FOURTH AND FIFTH GENERATIONS

No semi-sterile plants have been tested beyond the third generation, but fertile plants remain fertile in pollen and ovules in F4 and F5. Several acres of those fertile plants which are of agricultural value have been grown in F5, and many flowers and pods examined, all of which were fertile.

In this investigation the pollen of over 2600 flowers has been examined under the microscope, and about 2300 young pods and 3700 dry pods have been opened, and the seeds and aborted ovules counted. In 1910, two acres of plants were grown; in 1911, the

experiment extended over nearly seven acres; in 1912, there were three acres; and in 1913 over two acres of individually numbered plants, and several acres of different families, were grown. The results given here are based on an individual study of over 2000 of these plants, grown eight feet apart, and (except in 1910) on eight-foot or four-foot poles.

These plants are favorable for an investigation of semi-sterility since no complications arise from self-sterility, incompatibility, or intercrossing by insects. Also, the dry pollen is easily squeezed in a mass from the closed keel, and the seeds and aborted ovules can readily be counted in the dry pods as well as in the green pods. (Data with regard to one complication due to imperfect self-pollination and too short style will be given in a forth-coming paper).

The random abortion of half the pollen-grains and half the embryo-sacs, and the splitting of the progeny of the semi-sterile plants into half semi-sterile and half fertile, as well as the constancy of the fertile plants, agree in all details with a simple Mendelian hypothesis, in which the pollen-grains and embryo-sacs, not the zygotes, are the *individuals* affected by segregation. If the Velvet bean has a factor whose absence stops the development of those pollen-grains and embryo-sacs which lack it, and the other three allied beans have *another* similar factor segregating independently, then those pollen-grains and embryo-sacs of the hybrid which have *both* factors will be abnormal, because unlike the zygote, they normally have *single* and not *double* factors. Hence those pollen-grains and embryo-sacs which lack both factors, and those which possess both factors, alike fail to develop. This hypothesis can be verified or disproved by appropriate crosses between different fertile lines, which I hope to undertake.

THE POINTS OF INTEREST.

The following are noteworthy points:

(1) Accurate knowledge of the exact degree of sterility of some hybrid plants can be obtained by microscopical examination of the pollen of healthy flowers, and of microtome sections of the ovules.

(2) The explanation of the random abortion of half the pollen-grains and half the embryo-sacs must apparently be by the segregation of Mendelian factors among these individually, and *not* by the action of these factors on the zygotes.

(3) Semi-sterility resulting from crossing is apparently one of the simplest cases of sterility, and a knowledge of its inheritance may help in the investigation of the probably more complicated inheritance of the greater degrees of sterility found in many first-generation hybrids.

I wish to thank the Plant Physiologist of this Station, B. F. Floyd, for verifying my numerical results by an independent examination of the pollen-grains and the series of sections of ovaries of the hybrid (Velvet by China); and also C. D. Gunn, and C. W. Long, who have done much careful work, especially in counting seeds and examining flowers.

NOTE. I will send seeds of semi-sterile plants to any member of the American Genetic Association who may require them.

Neglected Opportunities

If a tenth part of the labor and cost now devoted by leisured persons, in this country alone, to the collection and maintenance of species of animals and plants which have been collected a hundred times before, were applied to statistical experiments in heredity, the result in a few years would make a revolution not only in the industrial art of the breeder, but in our views of heredity, species and variation.—William Bateson: Mendel's Principles of Heredity (1902).

A report from Berne, Switzerland, states that the Swiss Society of Public Utility for Women has established a bureau for the medical examination and certification of women for matrimony.

ORIGIN OF CULTIVATED OATS

Difference in Ancestry has Vital Bearing on Adaptability of Varieties—Forms Derived from A. Sterilis Best Suited to Southern Countries—Possibilities of Hybridization—Indication that Environment is Factor in Causing Variation—Influence of Culture and Result of Mutations

Dr. L. Trabut

Director of the Botanical Service of the Government of Algeria, Algiers, Algeria.

ALTHOUGH botanists have in the past usually considered that the many varieties of cultivated oat were descended from Avena fatua, *research has now proved that several species are to be found in the ancestry of these cultivated varieties, and particularly that those grown in the Mediterranean region mostly trace back to* Avena sterilis. *In future planting, therefore, and in attempting to extend the region where oats can be successfully grown, it is absolutely essential that regard be paid to the botanical affinities of the variety chosen, so that time and energy shall not be wasted by attempts to grow descendants of* Avena fatua *of temperate climates in subtropical regions where only* A. sterilis *will flourish, or in a dry region where* A. barbata *is best adapted to cultivation. The prevailing belief that oats can not be grown in the southern United States is probably based on the fact that all the experiments made there have been with cold-climate oats. A great deal of money has already been lost by such attempts, foredoomed to failure because of the unsuitableness of the material:—although suitable material might have been had, and the country's wealth thus enormously increased, had growers studied the genetic history of the cultivated oats earlier. From this point of view, the interesting studies of Dr. Trabut have such practical importance to plant breeders throughout the world that the council determined to republish them from the Proceedings of the Fourth Congress of Genetics, to which body they were communicated at the meeting in Paris in 1911. The translation is by S. C. Stuntz.*

In studying the section Euavena of the genus Avena with a little care, we are impressed with the great number of secondary forms which constitute the species, often living in the midst of cultivated crops in "outposts" established as a result of their wide dispersion outside of the region of their origin.

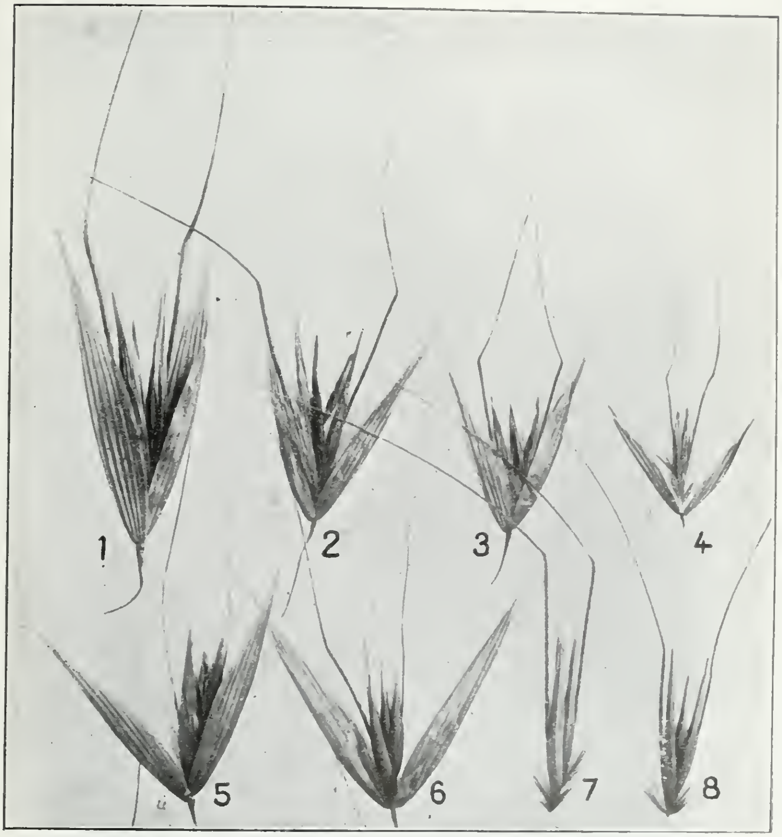
Without doubt these forms may be ascribed to the influence of cultivation, causing variations, or favoring forms which would not find place under the natural conditions of existence. I am even convinced that it is by this involuntary cultivation that man has caused the appearance of the useful races of the genus *Avena*.

But, not to depart from the realm of fact, we know that on the Mediterranean litoral we are able to bring together the following very important series of *Avena sterilis*, beginning with the most useless forms and ending with an oat largely cultivated in the Mediterranean region, and up to the present wrongly confounded by both scientific and practical writers with *Avena sativa*.

COMPLETE SERIES OF FORMS.

Avena sterilis maxima Perez Lara, Fl. Gad. (fig. 11, No. 1). Inflorescence few-flowered. Spikelets very large, the glumes attaining 50 mm.; lemmae covered with long hairs, and bearing a strongly developed, geniculate and twisted, often hairy, awn.

A. sterilis segetalis Bianca, Todaro



SERIES OF FORMS OF "ANIMATED" OR "FLY" OAT

All of the above are merely varieties of *Avena sterilis*, and a glance at them, when they are side by side, shows plainly the mistake made by writers who considered the two extremes as separate species, making the Algerian oat a form of *A.sativa*, when it is really a form of *A. sterilis*, in which the awns have been reduced and the articulation consolidated through a complete series of intermediate forms. The varieties are as follows: 1. *Avena sterilis maxima.* 2. *A.sterilis.* 3. *A.sterilis ludoviciana.* 4. *A.sterilis micrantha.* 5. *A.sterilis segetalis.* 6. *A.sterilis pseudovilis.* 7. *A.sterilis calvescens.* 8. *A.sterilis pseudovilis.* (Fig. 11).

Exsicc. Sic. 712 (fig. 11, No. 5). Spikelets a little less voluminous, remarkable because of the great reduction of the not geniculate and barely twisted awn. Sicily in cultivated fields. A form very close to this is quite common in Algeria in cultivated fields; the seed is large and the lemmae are black.

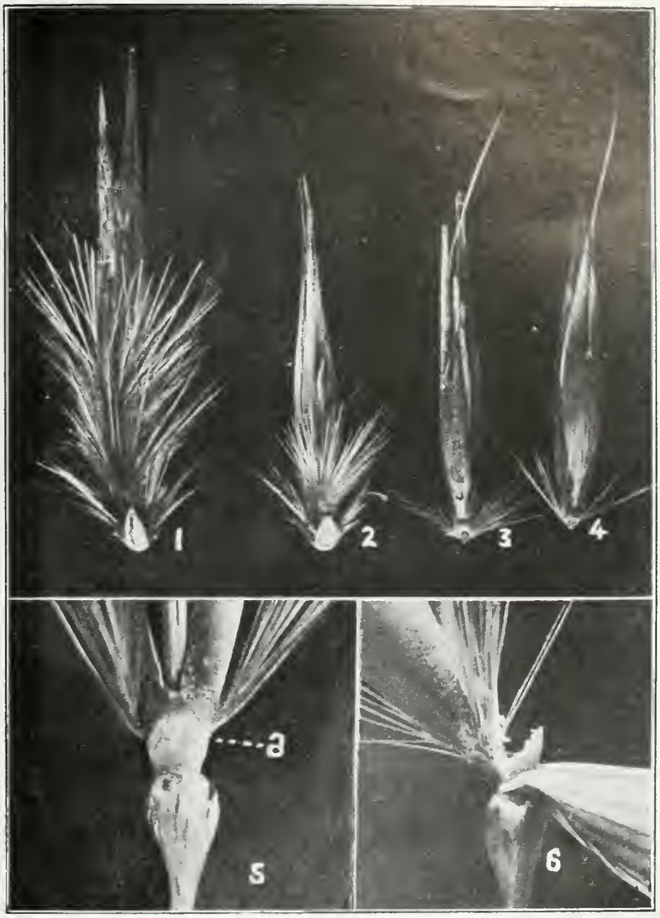
A. sterilis calvescens Trabut and Thellung, Vierteljahrssch. Naturf. Ges. Zurich, vol. 56, p. 315, 1911; *A. sterilis var. A.* Trabut (Compt. Rend. Acad. Sci., vol. 491 p,. 227-229, 1909). Lemmae coriaceous, glabrous, awn twisted, geniculate, but the callus still very hairy (fig. 11, No. 7).

A. sterilis pseudovilis Hausskn. Kritische Bemerkungen über einige Avena Arten, 1894. *A. sterilis var. B.* Trabut, *loc. cit.* This variety differs but little from the cultivated form in which no hairs are found except on the callus of the lower flower, the awns are reduced, but at maturity the spikelet separates very easily from the glumes (fig. 11, No. 8.).

THE ALGERIAN OAT

Above is a head of *Avena algeriensis*, a single spikelet of which is shown below, at the left. Next to this is a photograph of the grains shown in more detail, at the right of which the second seed is shown alone. On the extreme right of the photograph (lower section) is shown the product of an improved variety of this type. (Figure 12.)

A. sterilis byzantina (Koch) Trabut. *A. byzantina* Koch (Linnaea, col. 21, p. 392. 1848). *A. sterilis var. Y.* Trabut, 1910. B. A. Alg. Tunis. This form was described by Koch in 1848. M. Thellung has established the synonymy of this interesting variety. Cosson (Bull. Soc. Bot. France, vol. 1, p. 15, 1854) and the contemporary authors have referred *A. byzantina* Koch to *A. fatua*, more especially to the glabrous forms: *A. hybrida*, *A. fatua glabrescens* Cosson. Haussknecht published it as *Avena sterilis parallela* in 1885. *Avena sterilis*



ARTICULATIONS OF A. STERILIS

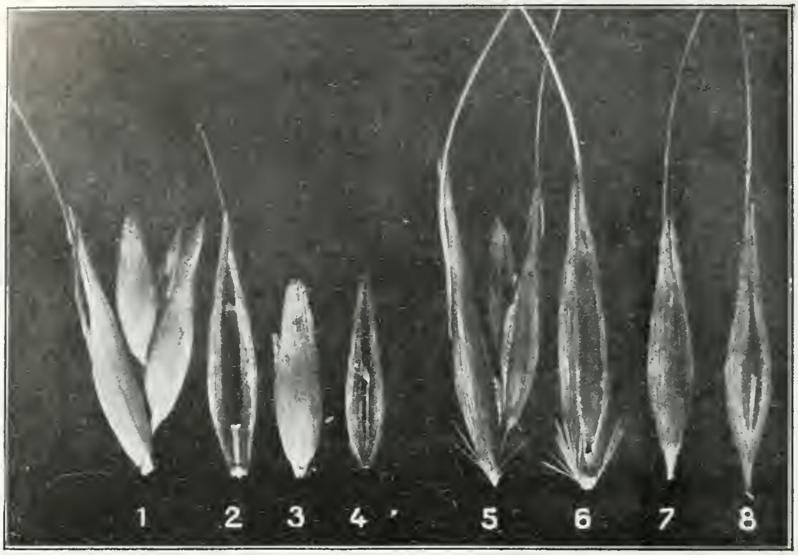
1. *A.sterilis maxima.*—2. *A.sterilis glabrescens.*—3. *A.sterilis byzantina.*—4. *A.sterilis culta.*—5. The same, viewed from the front.—6. The same, viewed in profile. The articulation is perhaps the most distinctive character of this species, and the progress of amelioration in the cultivated varieties simply leads toward a greater consolidation of the articulation. (Figure 13.)

byzantina has largely lost the characters of the sterilis type, and constitutes the last stage before reaching the cultivated form; the awn is reduced, the hairs of the callus are reduced, the articulation is still well preserved and the flowers fall easily at maturity, and the lemmae are also more lengthened than in the cultivated races. In 1907 M. Hackel wrote me that he considered this form as intermediate between *A. sativa* and *A. sterilis* and named it provisionally *A. sativa biaristata* (fig. 13, No. 3.)

A. sterilis algeriensis Trabut, 1910. *A. sterilis culta.* The Algerian oat is the cultivated form of the sterile oat. It is characterized by the reduction of the awn and the consolidation of the articulation.

THE ALGERIAN OAT.

The Algerian oat (fig. 12) is very widely distributed in the whole Mediterranean basin where it has long been recognized by growers: MM. Denaiffe



THE TWO SPECIES CONTRASTED

Nos. 1, 2, 3, 4, are the ordinary cultivated oat of temperate regions, *Avena sativa.* 1. The spikelet. 2. The lower flower with the fragment of the axis which bore the second flower. 3. and 4. The second flower, disarticulated. Nos. 5, 6, 7, 8 are the Algerian oat, a cultivated form of *A.sterilis,* which can be most easily distinguished by its method of disarticulation, in which the second flower carries away its own axis, as shown in 7 and 8. No. 6 shows the third flower without the second axis (compare with No. 2, showing the same flower in *A. sativa*), while No. 5 shows the whole spikelet of this Algerian oat. (Figure 14.)

and Sirodot[1] in their monograph on oats, in connection with the Abruzzi oat, indicate good characters and even propose to separate the Abruzzi oat and the Algerian and Tunisian oat as sections of *A. sativa.* Haussknecht, who studied the forms of sterilis very conscientiously, expressed the wish to see a useful race arise some day from this group which is so well adapted to the Mediterranean region; in 1894 in the Mittheilungen des Thüringisches Botanisches Vereins (n. f. no. 6, p. 39), he expressed himself thus: "For the countries of Southern Europe, *Avena sterilis,* improved by cultivation, on account of its larger yield, would produce a very desirable forage plant, especially where our *A. sativa* will not thrive well." If Haussknecht had had occasion to study the southern oats in the field, he would certainly have declared that his wish had for a long time been realized, and that his *Avena sterilis parallela* was nothing more than an escape from cultivation. The existence of a whole series of forms uniting the most characteristic *A. sterilis* with the oat which is cultivated in southern countries, is a strong chain which cannot be neglected, while a study of the morphological and physiological characters of the Algerian oat reveals affinities which no longer leave any doubt.

The section of *Avena sativa* characterized by non-articulate flowers which are separated only by the breaking of the axis, is based on an artificial character. It is because of cultivation that the articulations have ceased to function.

The group of *A. sativa* is made up only of the hairless and ankylosed oats of the other sections *biformes* and *conformes.* *Avena sativa* has retained all the characters of its ancestor, *A. fatua.* The second flower still separates easily from

[1]L'Avoine, pp. 181, 301, 1901.

THREE TYPES OF CARYOPSES

Reading from left to right, the first two are of *Avena sterilis maxima*, the third and fourth of *A. sterilis culta* (the ordinary Algerian oat), while the last, at the extreme right, is *A.sativa*, the ordinary oat of temperate regions. It will be noted that the caryopsis of the Algerian variety is as voluminous as that of the best races of *A.sativa*, but a little more lengthened. (Fig. 15).

the axis which persists above the lower flower, the articulation of the lower flower is more completely obliterated and it is a true rupture which permits it to separate from the glumes.

DISTINCTIVE CHARACTERS.

In the cultivated form of *A. sterilis* or Algerian oat, the basilar articulation is still very evident. The separation is not as easy in the cultivated race, as in the wild type, but the line of demarcation and the articular surfaces may easily be recognized. The second flower, which is not articulated in *A. sterilis*, as in *A. fatua*, remains adherent for a long time. It does not separate without carrying away at its base the axis itself, which constitutes one of its most characteristic points (fig. 14, no. 7). These two characters make it possible to recognize at sight the cultivated oats decended from *A. sterilis*, races which otherwise are very little different, and do not constitute so varied a series, as do the forms of *A. sativa* derived from *A. fatua*.

The caryopsis of the Algerian oat is as voluminous as that of the best races of *A. sativa*, but it is a little more lengthened (fig. 15, no. 2).

Avena sterilis culta has the panicles generally few flowered, of from twenty-five to fifty spikclets; it suckers more than *A. sativa*, and when cut green, the Algerian oat will even give a second crop with rather numerous full panicles.

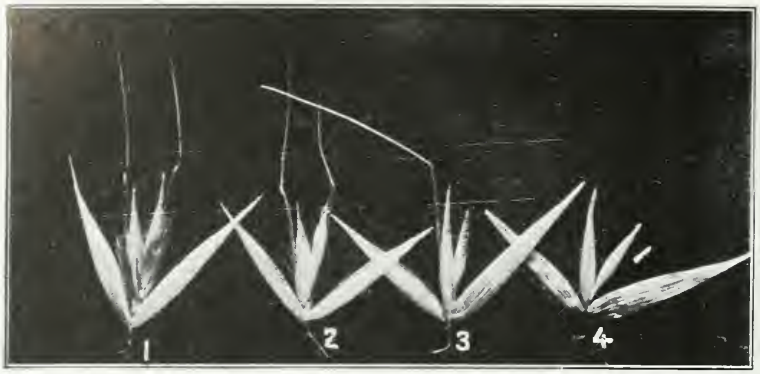
The importance of this distinction, besides its interest as indicating the origin of one of our most widely cultivated plants, rests above all in the very peculiar aptitudes of the races derived from *A. sterilis*.

Since 1895, in the oat experiments undertaken at the Botanical Station[2],

A WILD BLACK OAT

This form of the Algerian species is sometimes found growing spontaneously. It has been named *A. sterilis segetalis f. nigra*, and a commercial variety has been produced from it, by selection to reduce the awns. It has been introduced to the United States. (Figure 16).

[2]Of Maison Carré, near Algiers.



TYPES OF THE WILD, TEMPERATE OAT

Four forms of *Avena fatua*. 1. *A.fatua* itself. 2. *A.fatua glabrescens*. 3. *A.fatua subuniflora*. 4. *A.fatua subuniflora inermis*. The second has sometimes been supposed, without any proof, to be a hybrid of *A.fatua* and *A.sativa*. The third is found at considerable altitudes in Algeria, and sometimes presents awnless individuals (no. 4), which could easily be fixed to produce an awnless variety of this subspecies. (Figure 17).

I have proven that very few varieties give satisfactory results in cultivation along the coast. The few varieties which have resisted drought and rust were received under names Abruzzi oats, Naples oats, Tunisian oats, Spanish oats, Greek oats. They all have the same appearance and are practically indistinguishable. They are all *Avena sterilis culta*.

This type derived from *A. sterilis* does not seem to have acquired any other characters than very secondary ones; color more or less bright awn more or less reduced, hairs of the callus more or less abundant. By careful segregation, a form with shorter grain, more swollen and of greater density (fig. 1, 2, no. 4) is obtained, but the lemmae remain hard, which is a very serious defect. A form with three grains may also be fixed.

ALKALI RESISTANCE.

The Algerian oat not only resists heat and rust, but also to a certain degree alkali in the soil. In the plains of Oran very extensive growths of *A. sterilis ludoviciana* are often seen in saline places.

It is evident from this form that it will be possible to obtain a race suitable for saline soils; there already exist glabrescent variations with reduced awns.

The results of my observations on the resistance of the Algerian oat, have, for a long time, attracted the attention of the experiment stations of Cape of Good Hope, Australia, and the United States, which have checked my statements and have made important distributions of seed of Algerian origin. The results obtained have been good.

From the point of view of genetics, it is interesting to show the great uniformity of *Avena sterilis culta*, while *Avena fatua sativa* has been almost overwhelmed by the multiplicity of its cultivated races.

I have tried hybridizing, after having shown that no cultivated form could be regarded as having the combined characters of the two species. It will be useful, by causing variations, to obtain the following modifications of the Algerian oat:

a) Reduction of the length of the lemmae. There already exist elementary forms showing this character, as well as the reduction of the awns.

b) Reduction of the hardness of the lemmae which make this oat less digestible. The weight of chaff in relation to kernel is nevertheless no higher in

TWO FORMS OF THE BARBED OAT

B The type (*Avena barbata*). It has given rise to a number of cultivated forms which seem especially adapted to dry regions. At the right (S) is one of these, *A.strigosa*, which has hitherto been grouped with *A.sativa*, but is merely a glabrous form of *A.barbata*, which has lost the fragility of articulations which characterize the latter. (Figure 18).

the Algerian oats. The proportion is, in harvests made under good conditions, 71% of kernels to 29% of chaff. But the experiments of Captain Bosnot, at the Horse Breeding Station at Tiaret, have shown that the Algerian oat has a coefficient of digestibility a little lower: thus with Houdan oats, 62 grams per kilo escaped digestion and with Algerian oats, 70 grams,—although the White Canada oat, in the same trials, has 75 grams not digested. Histological examination of the lemmae does not reveal any difference in thickness or consistency from those which are observed in *A. sativa*.

c) Selection by density quickly gives a practical result, perhaps still more evident in this species than in the ordinary oat.

d) The Algerian oat is of bright color, but there are also black races, derived from the black forms of calvescens and segetalis which are easily found at harvest time. *Avena sterilis segetalis f. nigra* (fig. 16) is such a race.

e) I have succeeded in fixing by selection a race of this oat having only a single awn, on the first flower, the awn on the second flower not developing.

DIFFERENCE IN DISTRIBUTION.

Avena fatua has a very different distribution from that of *A. sterilis;* this species is found on our high plains, the steppes or on the slightly humid Oranian and Tunisian littoral. Like *A. sterilis*, *A. fatua* presents numerous transition forms toward the cultivated type,—*A. sativa*.

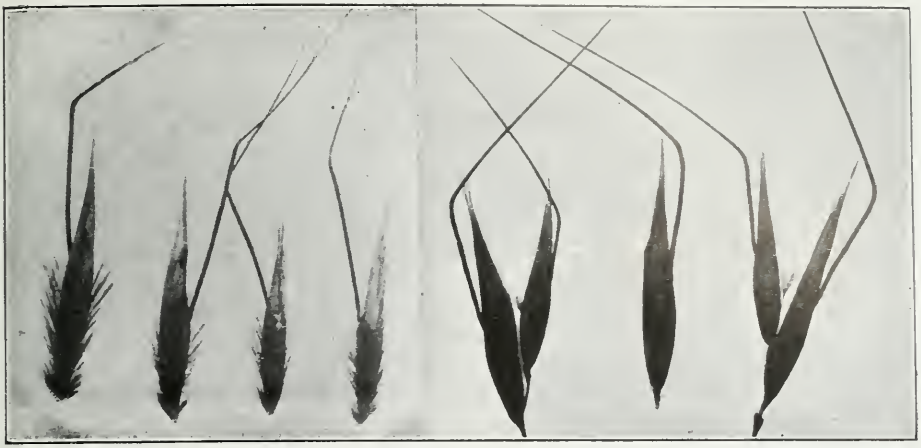
AVENA BARBATA TRIFLORA

A well-marked form of *A.barbata*. This species is found throughout much of northern Africa, the Abyssinian varieties being closely allied to it, if not identical. (Figure 19).

In 1854, Cosson (Bulletin de la Société Botanique de France, vol. 1, p. 15) distinguished an *A. fatua glabrescens* which merges with *A. hybrida* Peterm. (Flora Saxonica, p. 17, 1842). These forms have been regarded as hybrids of *A. fatua* and *sativa*, but without any proof. In the Sersou (altitude 1000 metres) I have found a link uniting *A. hybrida* with *A. sativa*.

This form (*A. subuniflora*) presents the general characters of *A. fatua;* but it is glabrous, the well indicated articulation functions badly, the second flower is most often abortive and the lower flower has a long twisted and geniculate awn (fig. 17, nos. 3-4) like the wild forms. In culture it maintains itself and presents at the same time some awnless individuals which it will be easy to fix. These transition forms are sometimes regarded as returns of a cultivated race to a wild state; this is possible, but it is certain that the supposed reversions of *A. sativa* lead toward *A. fatua*.

It is quite evident today that *A. fatua* has supplied the great majority of the cultivated oats brought together under the name *A. sativa,* and that it is still possible to bring together the whole series of intermediate forms between the wild type and the forms adapted to cultivation.



THE ABYSSINIAN OATS

1, 2, 3, 4, *Avena wiestii*, a hairy form growing wild in Abyssinia, and seemingly adapted to desert regions. 5, 6, 7, *A. abyssinica*, a cultivated form grown by the Abyssinians, not for grain, but for forage. In cultivation, all the transition stages between these two have been found. They offer a rich field to plant breeders, in the production of varieties of oat adapted to severe desert conditions. (Fig. 20).

OTHER SPECIES EXAMINED.

A. barbata. The creation by Linnaeus of an artificial species (*A. sativa*), comprising all the forms of Avena not disarticulating themselves, has for a long time misled searchers wishing to clear up the origin of *A. sativa*.

If we are able to admit as demonstrated that *A. sterilis* and *A. fatua* have transformed themselves into two cultivated oats, it remains for us to examine the other species to see if they have not undergone the same modifications by cultivation and if they have not become usable after having been weeds.

In examining *A. strigosa* Schreber, which has also been included with *A. sativa*, there is little delay in finding all the characters of *A. barbata*, not taking into account the functioning of the articulations and the pilosity, two fluctuating characters without value, as we have seen in *A. sterilis* and *A. fatua*. *A. strigosa* is indeed the glabrous form which has lost the fragility of the articulations of *A. barbata*.

Haussknecht (l. c. 1894, p. 20) has observed the intermediate form, var. *solida*, but it appears very rare. In examining a great number of plants of *A. barbata*, I have never found anything other than a three-flowered, robust form with large spikelets, different from *barbata triflora* Wilk, and from the two-flowered forms with lagre spikelets growing in grain fields.

In cultivating *A. strigosa*, I have obtained transition forms towards *A. barbata*, with the spikelets of the lemmae almost as pilose as in the wild type, but with more solid articulations.

A. brevis Rotl which has been described as a form of *A. sativa* is connected with *A. strigosa*, derived of course from *A. barbata*.

THE ABYSSINIAN OAT.

Avena abyssinica. My study of *A. barbata* for the Flore de l'Algerie led me to separate the southern forms and those from the Sahara under the names of varieties *fuscescens* and *minor*. Haussknecht has since (1894) identified these desert forms with *Avena wiestii* Steudel.

A. Wiestii differs little morphologically from *A. barbata*, but it is nevertheless a form interesting because of its habitat. In northern Africa, it appears very widely distributed in sub-saharan localities. In Cyrenaica, Taubert collected at Derna a form *solida* (exsicc. no. 507) which is the transition stage toward cultivable forms. I have received from Abyssinia, from Dr. Bald-

rati, director of the Office Agraire Experimental, two lots of Abyssinian oats; one, Dr. Baldrati writes me, is made up of an abundant spontaneous form, the other of the form cultivated not for grain, but for forage. The wild oat was hairy with very fragile articulations. The other was glabrous or pretty near it, and with articulations retaining the grain better.

In cultivation at the Botanical Station, I have found all the transition stages between *A. wiestii* and *A. abyssinica*, which is the cultivable form of it.

A. abyssinica has therefore been wrongly connected with *A. sativa*. It is a form still half-wild. It appears, also, to be produced by the transformation of a native Avena, developed and modified in cultivation.

Although the differences between *A. barbata* and *A. wiestii* may be of little importance, it seems that these two plants are unequally xerophilous in dry places, *A. barbata* being simply the oat of the arid places of the Tell (the coastal region of Algeria), while *A. wiestii* is purely a desert plant.

The domestication of *A. wiestii* is as yet no more than outlined; it will be necessary to perform a vigorous segregation of the forms in the mixture and by appropriate treatment, either quickly or gradually by using patience, to obtain cultivable races superior to the *A. abyssinica* in use by the Abyssinians.

ORIGIN OF AWNLESS OATS.

In this study of the materials within my reach I do not pretend to have elucidated completely the question of the origin of all our oats. The awnless oats are also connectable with primitive species. If all transitions between the wild and the improved forms (intermediate forms which one may regard as the stages of a gradual improvement by culture), are found in the series of cultivated oats, it appears admissible for the awnless oats, that sudden mutations might have intervened. These oats are characterized by teratological anomalies; they are monstrosities such as produced *Triticum polonicum*.

The large Chinese awnless oat has the closest analogy with *A. sterilis*. I have been able to hybridize it with *A. sterilis culta*.

The study of the domestication of Avena presents, from the genetic point of view, some rather substantial arguments in favor of an ambient medium, a modifying agent causing fluctuations which end in the formation of varieties well characterized and fixed by selection.

Avena fatua in cultivation loses the fragility of its articulations, its hairs, its awns. It becomes a domesticated plant, but all the stages of its changes are easily retraced. Cultivated in very diverse surroundings, *A. sativa* has today a very numerous and extremely varied lot of domesticated descendants, as should be the case if the environment causes fluctuations.

A. sterilis culta has not been submitted to the same tests. This variety, cultivated on the Mediterranean borders, has until recently never been carried to other climates. The influence of the cultural environment appears to be very rapid, since Buckmann according to Darwin (Variations of Animals and Plants under Domestication, p. 330, New York, 1897) in a few years of careful culture and selection, converted *A. fatua* into two cultivable races, almost identical with the races already cultivated.

In oats, the modifications of the wild types are in reality not deep. The suppression of the fragile articulations has been considered as having much too great importance in Avena, as in Triticum and Sorghum. The fragile rachis may become tenacious by the simple play of fluctuating characters. It is nevertheless worth while to remark that in the natural habitat, the fragility of the rachis is never lacking in the wild types. This transformation seems to take place only under the influence of cultivation.

Hybridization between the cultivated species of oats has not yet been methodically attempted to my knowledge, and there is here a very interesting open field. It is true that we have yet to determine in what degree a true hybridization will be possible. If *Avena fatua sativa* may be crossed with *A. sterilis*

culta, a progeny may be produced having very useful mixed characters. *A. abyssinica* will gain by being crossed with the really superior *A. strigosa*. But in the matter of hybridization there is much more to be gained from experimentation than from the mere discussion of theoretical views.

SUMMARY.

Until recently, *Avena fatua* has been regarded as the ancestor of the cultivated oats comprised under the term *Avena sativa*.

Study of the wild forms of *Avena sterilis* has led me to consider that the cultivated oats of the Mediterranean countries are descended from this wild species.

The Algerian oat, and the oats of Italy, possess morphological characters found in *Avena sterilis*.

Avena barbata has given rise to some cultivated forms, such as *Avena strigosa*.

These three wild types of Avena appear to have been modified by cultural influences. In various cultures of the cereals, of flax, etc., may be found mutational forms which nearly approach cultivated types. One series of forms is characterized by the reduction of the hairs on the glumes, in another series the awn is reduced, and a third series is distinguished by the solidity of the rachis, which becomes gradually less articulated. A variation of the nature of a monstrosity may also be observed, in which the glume is less compact, so that the caryopsis falls out before maturity. This mutation gives rise to "naked oats."

In conclusion, at least three wild species of Avena, under the influence of culture, may acquire characters fitting them for cultivation. These three species preserve the ancestral characters by which they are adapted to different climates.

Avena fatua gives rise to oats adapted to temperate and mountainous regions; *Avena sterilis*, to oats adapted to the southern countries, and to saline soils; *Avena barbata* to races adapted to dry countries.

PLANS FOR INTERNATIONAL CONGRESS

The American section of the international committee on arrangements for the second International Eugenics Congress met last month. Bleecker Van Wagenen and Frederick Adams Woods were the members present, while H. H. Laughlin, W. Bayard Cutting and C. B. Davenport met with them by invitation. An organizing committee for the next congress was selected, as follows: David Fairchild, Frederick Adams Woods, Raymond Pearl, E. L. Thorndyke, Vernon L. Kellogg, and C. B. Davenport, chairman, This committee met in New York city on January 2 and elected Henry Fairfield Osborne of New York as president of the congress, which will be held in that city in September, 1915.

The Promise of Mendelism

When it is remembered that in wheat, for example, resistance and nonresistance to the attacks of disease, earliness and lateness of ripening, good and bad milling quality, are all pairs of Mendelian allelomorphs, and that it is now possible to take a different example of each of these qualities from each of three different strains, and to combine them together in a single new variety with perfect certainty and in four generations, it does not require much imagination to foresee that every department of the animal and plant breeding industries must sooner or later benefit enormously from Mendel's discovery.—R. H. Lock: Recent Progress in the Study of Variation, Heredity and Evolution (1906).

MENDELISM IN GREAT BRITAIN

Careful Experiments Being Carried on in Many Ways to Determine Operation and Limitation of Laws of Heredity—First Researches Purely Experimental, but Intensely Practical Ones Now Being Made by Numerous British Men of Science

R. C. Punnett

The Arthur Balfour Professor of Genetics in the University of Cambridge, England.

THE dramatic discovery of Mendel's work on plant-hybridization in 1900 inaugurated a new era for the breeder of plants and animals, and the opportunities for advance in the knowledge of heredity were in no country more rapidly seized than in Great Britian. The seed here fell upon prepared soil, for the problems to which Mendel found a key had already begun to engage the attention of Mr. Bateson and of Miss Saunders in Cambridge. The account of the experiments which they had started in 1897 and published as the well-known first report of the Evolution Committee to the Royal Society in 1902 was the most important contribution to the subject since Mendel's own paper, and was the first to open men's eyes to the vast possibilities latent in Mendel's work. A group of workers rapidly gathered round Bateson in Cambridge, and the contributions to be found under the names of Doncaster, Gregory, Lock, Staples-Browne, Miss Durham, Miss Wheldale, and others bore witness to the activity of the rising school of genetics in the University.

All this work, like Mendel's own, was designed and carried out purely with the desire to gain definite knowledge of the workings of heredity, and little or no attention was paid to the economic results which might flow from the application of this knowledge to the affairs of those who bred animals and plants for profit. The material for study was selected on the ground of its cheapness, of the ease with which it could be worked, and of its suitability for giving a speedy answer to the problems put to it. Sweet-peas, mice, stocks, moths, snapdragons, and poultry—such was the material investigated, and except for the last-named it could hardly be said to possess much economic importance.

CEREAL IMPROVEMENT.

But it so happened that the stimulus to genetic work coincided with the rapid rise of the School of Agriculture in the University, and the enormous practical importance of the new knowledge was immediately appreciated by Professor Biffen, who was then starting his now-famous experiments in the crossing of cereals. By making use of the methods of Mendelian analysis he was able to show that such qualities as strength, yield, and immunity to rust were transmitted in accordance with Mendel's law of segregation, and consequently are under the control of the investigator, who can now devise suitable experiments for combining them together at will. Improved wheats of this kind have already come into use in England, and, judging by the competition there is to secure the seed, they have already proved themselves a great success. The analysis of the wheat-plant is still being actively carried on

[1] Reprinted from the Bulletin of Agricultural Intelligence and Plant Diseases of the International Institute of Agriculture, Rome.

in Cambridge by Professor Biffen and his co-workers, and there is no doubt that as time goes on even better and more profitable varieties will be at the service of the British farmer.

It is pleasant to be able to record that the importance of the work has been recognized by the Government, who have placed a considerable annual sum at the disposal of the School of Agriculture for research in plant-breeding. This has rendered possible an increase in the scope of the work, and experiments are now being carried out on other plants besides cereals. Among investigations now under way are some concerned with the transmission of fertility in fruit-trees, while the striking success of Biffen's work on the nature of immunity to rust in wheats has led to the search for naturally immune individuals in other forms of plant-life. Experiments with potatoes have been in progress for several years, and, thanks to the energy of Dr. Salaman, working on his own estate near Cambridge, and of Mr. Lesley, of the School of Agriculture, the formation of a decent potato, naturally immune to *Phytophthora infestans*, seems within measurable distance of realization.

WORK WITH POULTRY.

Nor are the researches at Cambridge confined to plants. Poultry was one of the first subjects of experiment by Bateson, and during the past ten years much has been learned of the transmission of various characters. Offering as they do a number of features showing sex-linked inheritance, poultry are of importance for gaining an insight into the nature of sex, and of studying the peculiar influence of each sex in the transmission of hereditary properties. Several of these sex-limited characters are now under investigation at Cambridge, while parallel experiments are being carried on by Professor Bateson at Merton.

Two other series of experiments likely to lead to knowledge of economic value are also being carried on at Cambridge. The first of these is concerned with the inheritance of size, and consists in carefully following out the result of a cross between an ordinary fowl and a bantam. The work is not yet sufficiently advanced to permit of complete analysis, but the nature of the F2 generation raised last year strongly suggests that size depends upon definite factors which exhibit ordinary Mendelian segregation. The other set of experiments mentioned concerns the inheritance of the brooding instinct in the hen and of the brown color of the egg-shell. In England brown eggs are of greater value than white, but hitherto no breed laying brown eggs and in which the hens never want to sit has yet been established. It may be that brown eggs are incompatible with the non-broody habit, just as it is sometimes stated that a breed of cattle cannot be at the same time first rate in both milk-production and beef. It is hoped that the experiments in progress will eventually give definite evidence upon this point.

Experiments have also been undertaken with sheep where the results of a cross between merino rams (from Australia) and Shropshire ewes are being carefully followed. The experiments have just reached the F2 generation, and it is hoped that the knowledge gained from them will eventually render it possible to combine the fleece of the merino with the good mutton qualities of other breeds.

SWEET-PEA EXPERIMENTS.

Besides the work just mentioned, there are other sets of experiments being carried out at Cambridge and Merton which may be regarded as forming a group by themselves. Bateson in 1905 was the first to describe in sweet-peas a remarkable case in which two characters each exhibiting ordinary Mendelian segregation nevertheless showed a peculiar distribution with regard to one another. In this particular instance the characters dealt with were color, blue being dominant to red, and pollen-shape, long being dominant to round. Blue long x red round gave blue long in F1, and in F2 the expected ratio 3 blue: 1 red and also 3 long: 1 round. But the proportion of rounds among the blues was only about 1 in 12, whereas among the reds the rounds were in

excess of the longs to the extent of about 3 : 1. Since that date many other cases of this peculiar association of characters have been discovered in other plants as well as in sweet-peas, and certain generalizations have emerged from the study of them. We now know that if *A* and *B* represent two factors respectively alternate to their absence (*a* and *b*), then if the original cross is of the nature *AB* x *ab* the characters *A* and *B* will be more or less completely associated in the F2 generation, so that of the four possible classes *AB* : *Ab* : *aB* : *ab* the first and the last will be the most numerous. If, however, the original cross is of the form *Ab* x *aB*, then of the four classes in F2 the *AB* one will be about twice as numerous as either of the two classes *Ab* and *aB*, while the class *ab* will be very rare. Where *A* and *B* go into the cross in association they tend to remain associated in F2, whereas when they go into the cross dissociated they tend to remain dissociated in F2. This peculiar phenomenon is not as yet properly understood, and it is with a view to obtaining further knowledge that experiments are being carried on at Merton by Professor Bateson, and at Cambridge by Miss Saunders with stocks, by R. P. Gregory with primulas, and by the writer with sweet-peas.

Recent work, more especially that of Morgan in America, has shown that similar phenomena occur in animals, and there is no doubt that a proper understanding of them will eventually turn out to be of much importance for the breeder of plants and animals. It is a matter of common observation that characters seem at times to be transmitted in bunches, as it were, from one parent or other to the offspring, and it is likely that in such cases we are dealing with phenomena of the kind just outlined.

BATESON'S INSTITUTION.

The best-equipped institute in Great Britian for the study of genetics is undoubtedly the John Innes Horticultural Institution at Merton, near London. Started in 1909 with funds derived from private bequest, it was fortunate in securing Professor Bateson, who left Cambridge in 1910, as its first Director. Fortunately, also, its scope is broad, and the experimental work undertaken is concerned with the unravelling of the principles of inheritance in the widest sense, apart from considerations of direct economic return. Numbers of experiments are at present being carried out by Professor Bateson and his staff, principally with plants, not the least interesting being a series of experiments dealing with fertility and sterility in fruit-trees.

Besides Cambridge and Merton there are several other places where genetic research is being carried on. Mr. Hurst, one of the pioneers in Mendelian studies, has established an experimental station at Burbage, near Leicester, which aims at the production of economically valuable varieties of plants and animals by working upon Mendelian lines. Mr. Hurst is experimenting with many different plants and animals, and some of his most interesting experiments concern horses, and aim at the production of a pure race of steeplechasers—*i.e.*, of animals with a special aptitude for hunting.

Genetic research is also being carried on by Professor Keeble at University College, Reading, the chief material investigated being primulas. But perhaps the most interesting work from this source is that dealing with the chemical side of genetic problems. It is well known that in primulas there are white flowers of two kinds—viz., those dominant and those recessive to colored. Professor Keeble and Dr. Armstrong have recently amplified the work of Miss Wheldale and others, and have demonstrated that these two forms of white, though alike in appearance, can be distinguished by definite chemical tests. Such work opens up a new and important field of study, and it is possible that as this branch of knowledge develops the genetic analysis of plants and animals will be greatly simplified by the substitution of direct chemical tests for the elaborate series of breeding-experiments which are at present necessary.

Among the experimental work in progress in England should be mentioned that of Mr. Staples-Browne, of Bampton, near Oxford, who is continuing his researches with pigeons, more especially with reference to sex-limited characters; also the work of Trow, of Cardiff, who has recently contributed a valuable paper on inheritance in *Senecio*. In this paper and in another shortly to appear Dr. Trow has made a definite advance in the understanding of those peculiar cases of association between characters to which reference has already been made.

In Ireland, Professor Wilson, of Dublin, has lately brought together a number of records dealing with the heredity of coat-color in cattle and horses and with the milking-capacity of cows.

Scotland has also made a start by creating a Lectureship of Genetics in the University of Edinburgh, to which Mr. Darbishire was recently appointed.

In conclusion, it should be mentioned that the study of genetics in Great Britian is not confined to those who work on these islands. Cambridge sends her students all over the world, and the value of genetic research to the breeder is evidenced by the work of Balls on cotton in Egypt, and by that of Leake and of Howard on cereals, cottons, and other plants in India.

General Principles Not Enough

So far as practical results are concerned, it is not enough for men of science to investigate the facts and the principles of heredity, and to attempt to lay down the principles of eugenics, as the science which deals with the improvement of the race is now called. It is not alone enough for moralists to preach. The hope of the future lies in the slow development of those habits, those social instincts arising inevitably out of the actual facts of life and deeper than science, deeper than morals. The new sense of responsibility—of responsibility not only for the human lives that now are, but the new human lives that are to come—is a social instinct of this fundamental nature. Therein lies its vitality and its promise.—Havelock Ellis: The Problem of Race Regeneration (1911).

Scientific Knowledge Required

The question of improving the human race in this country has lately excited a good deal of attention. But without a scientific knowledge of the factors on which improvement and degeneration depend the discussion is not likely to be of much profit, and in such a case misdirected energy may be even worse than apathy. Without venturing to make any very positive suggestions, it may be at least pointed out that our present practice in these matters is in almost every case the very worst possible.—R. H. Lock: Recent Progress in the Study of Heredity, Variation and Evolution (1906).

Careful Selection Necessary

The principles of heredity teach us that education and training, however beneficial they may be to individuals, have no material effect on the stock itself. If they have any effect at all, this is undoubtedly unimportant in comparison with the effect which would be produced by the selection of individuals which exhibit desirable qualities. The demand for a higher birth-rate ought to apply strictly to desirables. Instead of this the cry is for education and physical training, processes which can have no permanent beneficial effect on the race.—R. H. Lock: Recent Progress in the Study of Heredity, Variation and Evolution (1906).

NEW PUBLICATIONS

THE INFLUENCE OF MONARCHS by Frederick Adams Woods, M. D. The Macmillan Company, 422 pp. $2.00.

This is an attempt to gauge the influence of the hereditary qualities of a man upon the history of his time; the man selected is the reigning sovereign.

The method of the study is to render a judgment, as objective and free from bias as possible, concerning the position of the reigning monarch in one of the three classes, plus, intermediate and minus. In the plus class one places the monarchs of exceptional talents for leadership, in the minus class are placed monarchs of feeble intellect and feeble moral control, in the intermediate class are placed those of intermediate qualities. In the same way, the change in the political condition and general prosperity of a country may be classified as plus, if very progressive, intermediate, if stationary, and minus if retrogressive. An agreement in the sign of the personality of the monarch and the prosperity of the country counts one for the hypothesis of influence of the monarch; a disagreement in sign counts against the hypothesis. The correlation in signs can be calculated and affords a measure of the influence of the monarch.

This method is applied in successive reigns in the medieval history of France, Spain, Portugal and the other leading nations of Europe. For example, the reign of the brave, wise, virtuous Gustavus Vasa led to the independence of Sweden and a vast development of her resources. In the following reign of the unwise, suspicious, headstrong Eric XIV treasure was wasted, national distress entailed and rebellion incited. Here the weak ruler permitted to decay what his strong predecessor has built up.

Altogether Dr. Woods finds 105 instances of a superior ruler associated with advancing conditions of his country as against only 11 cases where there is a decline. There are 87 cases where a national decline was associated with a weak ruler and 30 cases where there was progress with such a ruler but, in such cases, there was frequently a strong power behind the throne. If 0 measures no correlation and 1 perfect correlation, then the actual correlation found is measured by .6 or three fifths of a unit.

It still remains to consider the significance of this correlation. Did the conditions of national development determine the eminence of the king or *vice versa?* Evidence for the conclusion that the qualities of the king determine the fate of his country is found in three facts. First, the transition from + to — states of prosperity in the country is usually abrupt, closely following the accession of the king. Second, interregnums are almost always periods of national decline unless some strong member of the royal family is in control. Third, if conditions determined the rank of the monarch there should be less evidence of an inheritance of the intellectual qualities of a monarch than of some other characters not capable of being influenced by conditions, such as eye color; but the inheritance of intellectual qualities is not less than that of others.

The main conclusion that Dr. Woods draws from this study is "that the royal breed, considered as a unit, is superior to any other one family, be it that of noble or commoner." Proof that the superior quality of royalty is due to innate qualities is found in the facts that younger brothers are just as eminent in intellect as are those who succeeded to the crown; that many scions of royal houses have been exceedingly precocious; that, on the whole, their genius has been for war and government (for which the blood was selected in the first instance); and that 1 in 40 of royalty show intellectual preeminence of a grade not found in 1 in 4,000,000 outside of royalty. Royalty in Europe between the eleventh and eighteenth centuries is a demonstration of the overwhelming importance to a country of its "best blood."

C. B. Davenport.

Breeding Wild Game

What he considers the largest plant in the world for breeding and shipping live game is described by Paul Larsen in the December number of the Game Breeder. This is the estate of F. Horacek at Martinitz, Bohemia.

"The first day," says Mr. Larsen, "I visited the park for haired animals located in some high wooded hills. There are about twenty-five acres divided into five inclosures. Three of these usually contain six thousand hares and altogether twenty thousand are trapped in a season and brought to the inclosures. Mr. Horacek owns for trapping the hares, nets which are about nine thousand yards long, representing a value of over $8,000. During the season three thousand netters are employed to trap game. The other two inclosures are filled with deer and boars.

"The second day of my visit I enjoyed seeing the pheasantries and partridge aviaries. The first named consist of fifty-four covered and three open pens which will hold at one time about ten thousand pheasants. The second named consist of two hundred and ninety-eight pens, and over sixty thousand partridges pass through these inclosures during a season.

"While abroad I thoroughly studied the methods of distinguishing the sexes of partridges," the writer continues. "Most people believe that the reddish-brown crescent on the breast of the bird is a distinguishing mark of the male, but this certainly is not so. I observed that a large proportion of the hens have this mark and even larger and more well defined. One day while handling about two hundred birds, in order to investigate this subject, I ascertained that the best way of determining the sexes is that the males have a red spot just back of the eye which is especially prominent at the mating season. The general color of the male, also, is brownish while that of the female is grayish. The feathers of the first mentioned are marked lengthwise and crossed with brown stripes while the feathers of the female are barred with ashy-gray and sometimes with black stripes. The head of the male shows no pearl-like markings which can be observed on the head of the female."

On Marriage Certificates

Editorially reviewing recent American legislation on the subject of health certificates as a requirement for marriage, the Medical Record (New York, December 6, 1913) remarks:

"In many of these the provisions of the law have far outrun the results of scientific investigation. It is in fact still an open question whether confirmed criminals and feeble-minded persons are especially apt to propagate their own kind unless they mate with persons who, like themselves, carry a neuropathic strain. With few exceptions the impediments to marriage, imposed by the new legislation, appear to disregard the unsettled state of eugenic science, and assume that the theories advanced by this or that particular school have correctly solved the principles underlying the inheritance of good or bad germ-plasm."

Hereditary Chorea

Hereditary chorea, usually known as Huntington's chorea, is described in the Boston Medical and Surgical Journal for Nov. 6, 1913, by Dr. William A. Boyd of the Westport, Conn., Sanitarium. He reviews the history, from the discovery in 1842, of this disease, which is one of the most clearly marked and indisputable of the disease-factors of cacogenics, and manifests itself, in general, only in adult life. The disease has in recent years been studied by a number of geneticists, all of whom have borne witness to its highly transmissible character; Dr. Boyd adds a case from his own experience, and gives an extended bibliography of the subject.

Register of Hybrid Orchids

An undertaking which should prove of real value to genetists is the foundation by the Royal Horticultural Society of London of an orchid register, to keep an accurate record of crosses made, thus continuing the compilation of data started by Rolfe and Hurst's Orchid Stud Book, published by the Orchid Review of London.

The new register will be international in character, and compiled in harmony with the Vienna and Brussels Rules of Nomenclature. It is announced in the following letter from the office of the Royal Horticultural Society in Vincent Square, Westminister, London:

"*November 28th, 1913.*

"The President and Council, acting on the recommendation of a Sub-Committee of the Orchid Committee, have decided to establish a Register of Hybrid Orchids at Vincent Square. Mr. R. A. Rolfe, of Kew, has been appointed Recorder. The Register will include all known Orchids.

"The President and Council accordingly invite Orchid raisers and growers amateur and professional, to bring their Hybrids, *when in flower for the first time* (even though they may not then be sufficiently developed to enter for award), and to enter the name and parentage of the plant, together with the exhibitor's name and address, on a Registration Form, which can be obtained from the R.H.S. Office, Vincent Square, S.W. This Registration Form should be sent with the plant, and it will be placed before the Orchid Committee, who, after satisfying themselves that the name is in order, will enter it on the Register. Once so recorded the name must be recognized for all crosses of similar parentage when subsequently shown, unless valid reason can be otherwise produced.

"W. WILKS, Secretary."

Color Inheritance in Pigs

Reviewing the observations made in Germany and the United States on the inheritance of color coat in pigs, Gustav Fröhllich describes the general conclusions in the Berlin Journal f. Landwirthschaft, LXI, 3, according to the Bulletin of the International Institute of Agriculture, Rome:

It appears that in the first filial generation of crosses the following are dominant:

I. *White* of Improved German Swine (Edelschwein) over:
   white and black of Hanoverians
   black of Berkshires
   greyish-black of European wild pigs
   greyish-black of Cornwalls
   red of Tamworths.
   black of Caucasian wild pigs.

II. *Greyish-black* of European wild pigs over:
   red of Tamworth.

III. *Black and white* of Hampshires over:
   red of Tamworth.

Importance of Genetics

I venture to express the conviction, that if the facts now before us are carefully studied, it will become evident that the experimental study of heredity, pursued on the lines Mendel has made possible, is second to no branch of science in the certainty and magnitude of the results it offers. This study has one advantage which no other line of scientific inquiry possesses, in that the special training necessary for such work is easily learnt in the practice of it, and can be learnt in no other way. All that is needed is the faithful resolve to scamp nothing.—William Bateson: Mendel's Principles of Heredity (1902).

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INHERITANCE OF "MONGOLIAN" DEFICIENCY.

A common type of feeble-mindedness shows external indications by a type of feature which is called "mongoloid," because of a certain resemblance to that of some of the Mongolian races. The woman at the left has this appearance, yet the tests showed that she was normal mentally. She was admitted as an immigrant, and by a normal husband gave birth to the child at the right, which not only had the mongolian characteristics exaggerated, but was a pronounced imbecile. The child was deportable, and the mother of course went with him. There is nothing in the immigration laws at present to prevent the entry of such women as these, if they themselves can pass the mental tests, although it is evident from many such cases as this, that they transmit feeble-mindedness to their offspring, even though they themselves may seem to be normal. (Frontispiece.) (See page 122.)

PURE LINES AND SELECTION

Practical Idea of Stock Breeder and Theoretical Ideal of Biologist Differ—Evidence Advanced in Support of "Pure Lines" Inadequate—Variation in Asexual Reproduction—Experience With Hooded Rats Shows Selection Possible in Either Direction.

W. E. Castle,

Professor of Zoology in Harvard University and Research Associate of the Carnegie Institution of Washington.

CURRENT discussions among students of heredity about pure lines of animals and plants are likely to be very perplexing to those breeders of live-stock who pride themselves upon the excellence and purity to breed-standards of the animals which they keep. "Selection within the pure line," we are told by the biologist, "is without effect." But selection is the foundation principle of the stock breeder and a statement addressed to him that selection is useless in the breeding of any sort of domesticated animal, however pure, would be received with incredulity.

It may be worth while therefore to point out that the biologist, as quoted above, and the stock breeder are talking about very different things when they speak of "pure lines." The stock breeder has in mind a race of animals bred as closely as possible to a recognized standard. But he realizes that some individuals conform more closely than others to the standard of the breed, and his experience indicates that continual selection of the "some" rather than the "others" is essential to maintain the purity of the breed. He understands the biologist's dictum that "selection within the pure line is without effect" to mean that one animal is as good as another to breed from provided both belong to the same pure race, and his comment is "Nonsense", and he is quite right too.

But that is not the biologist's meaning. The biologist's "pure line" is an imaginary thing. I doubt very much whether it was ever realized in any actual race of animals or plants. It has no more relation to actual animals and plants than a mathematical circle has to the circles described by the most accomplished draftsman. All the circles of the draftsman have wiggles in them, if you look at them carefully enough; only the mathematician's imaginary circle is perfect. Now the biologist undertakes to be the mathematician of breeding and to construct an "exact" system of heredity in which the "pure line" concept holds a conspicuous place. He reasons thus: Individuals of the same parentage differ for two reasons, (1) because of inherited differences and (2) because of differences in environment. If differences of environment (soil and situation of plants, care and food of animals) could be altogether eliminated, then animals of the same heredity should be identical, and should produce only offspring like themselves. They would constitute a *pure line.*

THE BIOLOGIST'S REASONING.

The biologist reasons further: Although it is impossible to control the environment completely and thus make it uniform and so eliminate its effects upon variation, nevertheless the effects of environment are not *inherited*. Consequently, if two germ-cells could be brought together in fertilization to form an individual, each of which germ-cells was identical with the other in its heredity, a *pure individual* would result, so far as heredity is concerned, all of whose germ-cells would transmit the same inherited characteristics, and all would look alike except as they were

made to vary by the environment. But as the effects of environment are by hypothesis not inherited, all would breed alike regardless of their appearance, hence it would be useless to make any choice among them.

The pure line theory, as outlined above, like the theorems of the geometer, rests upon the validity of certain postulates, any one of which being disproved, the whole argument fails.

The pure line postulates are: (1) *The effects of environment are not inherited:* (2) *inherited characteristics do not vary.* The first of these postulates is a bone of unending contention among biologists, and the last word has not been said upon it yet. Practical breeders believe that good care and feeding are not wasted upon their stock, that not only the individuals so treated are benefited but subsequent generations also. It must be admitted, however, that the evidence is not satisfactory that subsequent generations are given a better endowment by better treatment of the present generation. What is inherited is capacity to utilize opportunities of the environment. It is doubtful whether utilization of the environment by one generation increases the capacity of the next generation so to utilize it, though we all optimistically hope for this outcome. Plant breeders have shown that plump, well-nourished seed produces more vigorous plants and larger harvests than shrunken ill-nourished seed, a seeming inheritance of environmental effects. But in reality the seed is only part embryo; part of it is food stuff, environment of the previous generation carried over bodily to form the early environment of the new generation. So that when we select well nourished seed we select, not only a bundle of inherited plant qualities, but also a good initial environment for the plant. On the whole the first postulate of the pure line theory stands, if not proved, at least *not disproved.*

The second postulate of the pure line theory is a much shakier one, but I must hasten to qualify the form in which it has been stated before it is disowned by all supporters of the theory. The Hagedoorns, who have championed the theory in *The American Breeders' Magazine* (Vol. 4, No. 3), are careful to say that inherited "factors, not characters", are constant. What they mean, I take it, is this. An animal has some visible character, such as black fur. The black color of this fur may, however, result from several independent physiological processes, or agencies, no one of which by itself produces a visible effect. These agencies, known or unknown, are *factors* in producing a black coat. Some of them may be inherited, others environmental. Although the blackness of the coat may vary (owing to variation in environmental factors) *its ultimate inherited factors do not vary.*

EXPERIENCE WITH MENDELISM.

What evidence is there for the idea that the ultimate factors of inheritance do not vary? First let us inquire how the idea originated. Ten years ago, when the rediscovered Mendel's law was new, it was supposed that characters which conformed with Mendel's law did not vary. They behaved as units in heredity; how could they vary; how could units vary? The gametes were "pure". Each one either contained or did not contain a particular Mendelian unit. Units could not be split or modified. This idea found its fullest development in Punnett's *Mendelism.*[1] Later investigations have shown beyond question that Mendelian characters do vary. Practically everyone has now abandoned the idea of "*gametic purity*", but the idea of purity has been shifted from the characters which can be seen to vary, to *factors* which may be imagined to be invariable, though they can not be seen.

We might at this point with propriety end the discussion concluding that factors which are imaginary, like the circles of the mathematician, are of necessity perfect and constant. This is practically the burden of East's argument in *The American Naturalist*[2]. But as the world has benefited by the speculations of the geometers, so, let us hope, it may profit by the speculations

[1]The Macmillan Co., N. Y., 1911.

[2]Vol. 46, No. 551, Nov. 1912.

of the biologist, especially if some means can be devised to test their validity by experiment.

Since the supposed "factors" of inheritance are invisible, we can not hope to deal with them directly by experiment, but only indirectly. Our method obviously should be to eliminate all environmental factors so far as possible and also all factors of inheritance except one. If then this one being present gives a uniform result and being absent gives a result also uniform but different, we can conclude the factor constant. But it is very difficult to apply this method to specific cases, since when variation is observed it is always possible to suppose that all factors but one have not yet been eliminated.

From existing experimental work what evidence have we for the idea of factorial constancy? Perhaps Johannsen[3] has contributed more than any other one person toward popularizing the idea of factorial constancy. Selecting size variations in bean seeds, he was sometimes successful in modifying the racial mean, sometimes unsuccessful. Whenever he was successful, he attributes the success to variation in genetic factors; whenever unsuccessful he assumes that no variation in genetic factors occurred, i.e., that a *pure line* had been established, which could not subsequently vary unless hybridization occurred out of the race or a mutation occurred within it. It would be of much interest to know whether Johannsen's pure lines were as pure for all other characters as for size of seed and equally unresponsive to selection in all particulars of leaf and stem. For the bearing of his observations on seed size upon the question of the constancy of Mendelizing characters is not very obvious, since seed size does not Mendelize.

NO CLEAR-CUT DEMONSTRATION.

Although extensive observations upon the subject of size inheritance in both animals and plants have been made, they have resulted in the demonstration as yet of no single clear-cut Mendelizing unit character (or factor either). Dwarf plants, known to Mendelize when crossed with tall ones, form only an apparent exception; in reality they differ in *habit* rather than in size from tall ones.

The results of all observers, as regards the inheritance of ordinary differences in size, are closely in accord. When two races differing in size are crossed, the immediate offspring are intermediate in size. The next generation of offspring is likewise intermediate but more variable as a rule, and it has been found possible in some cases to select from them forms as extreme in size as the original parents. To interpret such cases as Mendelian requires the assumption that no single unit or factor is concerned in the size difference, but many wholly independent units. For a single Mendelizing unit would produce a wholly different result. But suppose we allow the assumption that many independent Mendelizing units or factors are concerned in the inheritance of size. The pure line hypothesis is not benefited by this assumption, unless we suppose further that these hypothetical factors do not vary. But this is an assumption wholly without warrant. For in all cases studied critically with reference to the constancy of characters demonstrably Mendelian, the characters have been found to be *inconstant* and subject to modification by selection. What ground is there, then, for supposing that in a case where no factors are demonstrable, such factors are *invariable?* This is like supposing that the moon is made of cheese and that further this cheese is *green*. The speculation is harmless, if one chooses to amuse himself that way, but it can scarcely be called a valid scientific conclusion.

Aside from the size selection experiments of Johannsen, which were made on a self-fertilizing plant, the experiments of Jennings[4] are most often cited in support of the view that selection within the pure line is without effect. In some respects the material used by Jennings was even more favorable than that of Johannsen. It consisted of a

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[3]Elemente der exakten Erblichkeitslehre, Jena, 1909.
[4]Am. Naturalist, Vol. 43, No. 510, June 1909.

species of small animal (paramecium) which ordinarily multiplies by dividing into two parts, each of which becomes an entire individual. Only at rare intervals does it reproduce by a method comparable with sexual reproduction in the higher animals and plants. If variation in genetic factors arises only from sexual reproduction, then asexually produced lines of paramecium should be devoid of genetic variation and so unaffected by selection. Jennings believed this to be true. He regarded the asexually produced descendants of a single paramecium as constituting a *pure line*, which selection could not change, and recognized several different pure lines isolated from his mixed cultures, each varying about a different average of size. Within each pure line he found selection ineffective.

IN ASEXUAL REPRODUCTION.

But considerable doubt is raised concerning the soundness of these conclusions by the subsequent work of Calkins and Gregory[5] who find that from a single "pure line" as defined by Jennings subordinate lines may be isolated which differ in mean size from each other more than the pure lines which Jennings supposed to be genetically different. If this is so, it must be possible for genetic differences to arise *in the course of asexual reproduction*, which on the pure line hypothesis is impossible; and if such genetic differences do arise, they afford material for selection to act upon with effectiveness, even within the supposed pure line.

Further evidence that racial differences may originate within an asexually produced and so genetically "pure line" is afforded by horticultural varieties of plants propagated asexually. Examples are found among apples and potatoes. An orchard variety which has endured for any considerable length of time is apt to develop sub-varieties. The same is true of varieties of potato which have enjoyed wide and long continued popularity. The *Williams* apple, widely cultivated in the eastern United States, occurs in two distinct strains, one conspicuously striped, the other nearly solid red. The *Baldwin* apple which has been in cultivation for over a century has developed sub-varieties differing in shape. The *Early Rose* potato, formerly the favorite early variety in the United States, developed sub-varieties, some of which were more elongated in shape than others.

So common are changes of this sort within asexually propagated varieties that botanists have given them a special name, that of *bud variations*. East, from his studies of bud variation among potatoes, concluded them to be ordinarily *loss* variations, or retrogressive variations due to the loss of some normal racial character, as are most of the germinal variations which arise as sports in the course of sexual reproduction among domesticated animals and cultivated plants. If so, we are led to conclude not only that variations may occur within a "pure line" asexually produced, but also that these variations are of the same nature as those which arise in the course of sexual reproduction. There can be no question of the effectiveness of selection in either category of cases.

The Hagedoorns think that evidence in favor of the pure line hypothesis is afforded by Vilmorin's varieties of wheat bred each from a single plant. They figure four heads of wheat selected each as typical of those produced by the ancestral plant 50 years ago, from which a pure variety has descended. Beside these they figure a typical head of each of the derived varieties at the present time. A strong resemblance exists in each case between the head of 50 years ago and the present day representative of the same variety, though this of course does not amount to identity. We are, however, told that "As can easily be seen from the photograph, all these generations of selection have not changed any one of the varieties one little bit."

EVIDENCE NOT COMPLETE.

The photographs afford a rather small basis for so sweeping a conclusion. We are not shown the entire plant of 50 years ago beside that of today; we know

[5]Journal of Experimental Zoology, Vol. 15, No. 4, Nov. 1913.

nothing about the appearance of its leaves, stem, or root; we know nothing of its physiological behavior under controlled environment; yet we are asked to believe the two plants, of 50 years ago and of today, *identical in genetic character*, because a selected head of one can be roughly matched with a selected head of the other. Does this prove that selection is without effect? Rather it proves that wheat can be selected to a type. What evidence have we that any attempt has been made in these 50 years to *change* the type? Not once, I venture, has the shortest headed plant been chosen in the long headed variety, or the *least* branched head in the branched headed variety. Yet on the pure line hypothesis, this would have made no difference in the result. How do we know that it would have made no difference, the experiment not having been made? Doubtless the pure line advocate would reply, because selection in the opposite direction has effected no change, the long headed race being now no longer and the branched headed race no branchier. But this assertion is not established by the photographs of matched heads, and even granting its correctness, it might well be that a physiological limitation had been reached 50 years ago which it has not been since possible to remove. When selection has attained the ultimate, it can go no farther. If I select animals spotted with white for increasing blackness and obtain an animal black all over, the task is accomplished. Nothing more can be done *in that direction*. This does not prove selection to increase or to decrease the white spots of animals to be ineffectual; indeed, the contrary has been fully established.

The Hagedoorns think further to strengthen the argument for the pure line theory by a challenge to its opponents to modify a character within a narrowly inbred line of animals by selection and then to bring the character back again to its original condition. "For," they say, "it is obvious that it may be possible by selection to get rid of such genetic factors as influence the character selected in a direction opposite to that in which we want to modify it, and thus to make great progress. On the contrary, if selection really might change genetic factors, modification of any character would be as easy in one direction as in the other." This test (in all essential features) has been applied repeatedly in a series of selection experiments with the hooded pattern of spotted rats (a Mendelizing unit-character) described in *Publication No. 195 of the Carnegie Institution of Washington*.[6] The experiments show that plus selection and minus selection are both effective, and that selection away from and back to any modal condition of the pattern are equally easy of accomplishment.

If I were disposed to use challenges for argument, I would make a counter challenge in these words—Let him who thinks selection ineffectual try it on any character of any animal. If he is persistent and critical in his experiments, I am confident that he will be convinced of the effectiveness of selection, as all practical breeders are, and will thenceforth regard "pure lines" as purely imaginary.

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[6]A preliminary account of certain of the experiments was given in Am. Breeders' Magazine, Vol. 3, No. 4.

R. H. JOHNSON IS CHAIRMAN

Professor Roswell H. Johnson of the University of Pittsburgh has been appointed chairman of the Eugenics Section of the American Association for the Study and Prevention of Infant Mortality, which will hold its next meeting at Boston in November.

THE JAMES RIVER WALNUT

Probably Cross Between Butternut and English Walnut—Shows Remarkable Vigor, Although Productivity is Slight and Nuts of no Commercial Value—Promising as Bud Stock for Timber—Vigor of Root Stock Increased When Scions of Hybrid are Used.

PETER BISSET,

Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C.

IN VIRGINIA, between Portsmouth and Richmond, on the south side of the James River, there is located the well-known and historical mansion of colonial days, "Lower Brandon." Across the river, just opposite "Lower Brandon" is "Rowe Farm", another of the old Virginia estates dating back to colonial days. On Rowe Farm there is growing one of the most remarkable walnut trees of which there is any record in this country.

The tree is of gigantic proportions, reaching a height of 100 feet, with its head, or crown of branches, towering above all other trees in the neighborhood. Its spread of branches was formerly 134 feet, but during a recent storm a large branch was broken off reducing its present spread of branches to 123 feet. At four feet from the ground the trunk of this tree measures 31 feet three inches in circumference, and at six feet from the gound, over 25 feet in circumference. At 12 feet from the ground the trunk divides into four large branches, three of which are larger than any tree in the neighborhood.

No one can tell how old this remarkable tree is, and there is no record to indicate its age. I am, however, informed that the old farm house on this place was built about 200 years ago and the supposition is that the seed or young tree from which this tree has developed, was planted at the same time. The size of the tree would lead one to believe that it is from 150 to 200 years old, and it also shows that the tree is of extraordinarily rapid growth, which is no doubt due to its hybrid origin, for if its rate of growth were the same as that of our native walnut, it would have had to be planted before the settlement of Jamestown—1607—in order to have attained its present size.

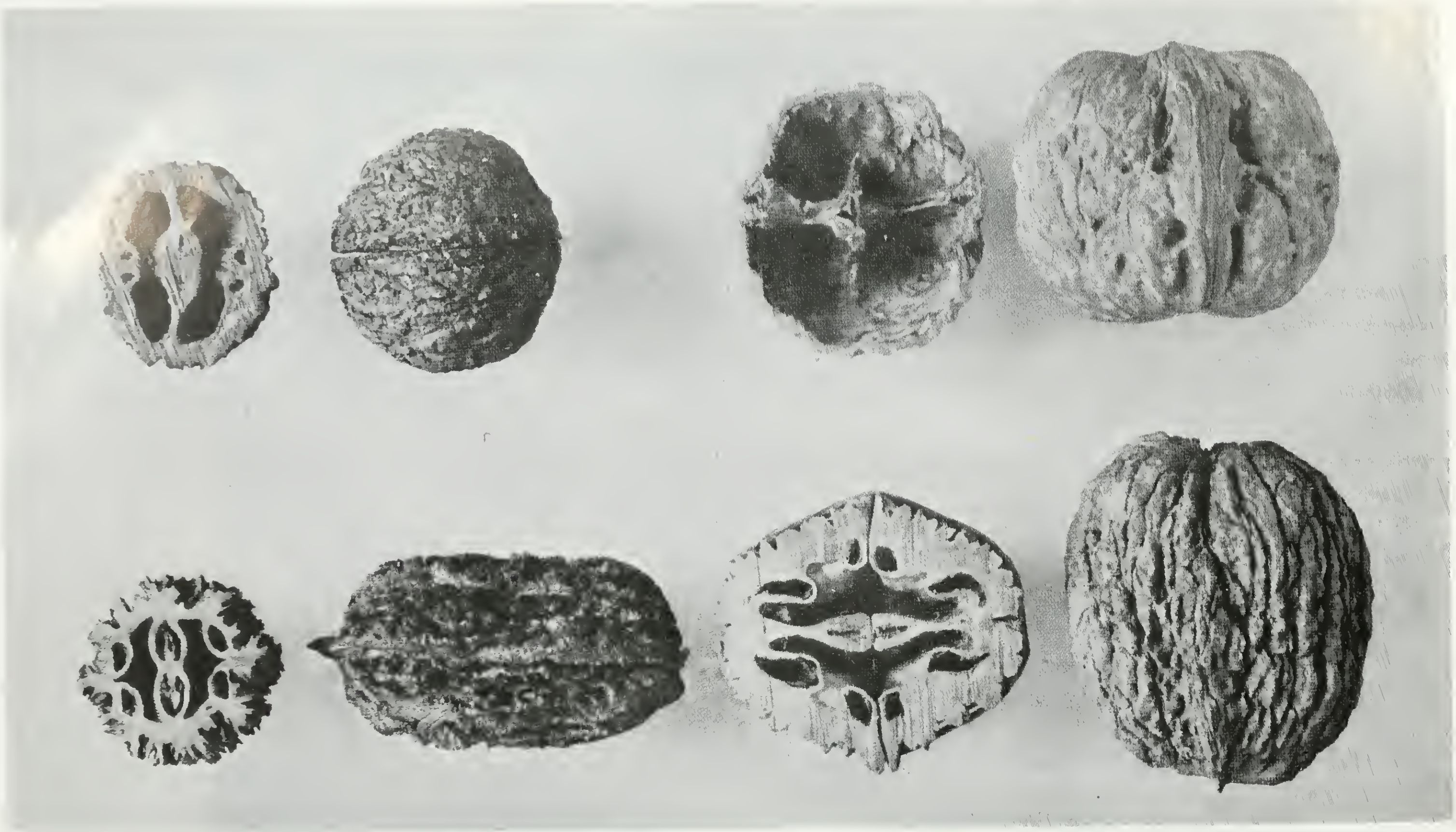
I believe this tree to be a hybrid between our native butternut walnut (*Juglans cineria*) and the Persian, or so-called English, walnut (*Juglans regia*). The outer pericarp, or husk, of the fruit resembles our common black walnut (*Juglans nigra*). The nut also, in many respects, resembles *Juglans nigra*, but it is of larger size and of elongated shape. The habit of the tree, the growth of the branches, the bark and the leaves, which are composed of from five to seven pairs of leaflets, their shape, entire margins and veining, would indicate a very close relationship to the Persian Walnut (*Juglans regia*). The kernel of the nut is so small that it is not considered of any value for home use, and it certainly is of no commercial value as an edible nut.

Prof. C. S. Sargent, of the Arnold Arboretum, Jamaica Plains, Mass., who has seen trees similar to this one, is inclined to believe it to be a hybrid between regia and nigra. I, however, am lead to believe that it is a hybrid between regia and cineria for the following reasons:

The leaves of the hybrid have little pubescent hairs at the base of and along the veins of the leaflets that are entirely lacking in any other species I know of. The shape of the nut is more like cineria than nigra, and upon examining a cross-

THE JAMES RIVER WALNUT TREE.

Professor C. S. Sargent of the Arnold Arboretum, Boston, called this the most remarkable tree in the eastern United States. Vigor is its most marked characteristic—note its size in comparison with the horse and buggy underneath. There is good reason to believe that it is a hybrid, and Mr. Bisset finds strong evidence to show that it is a cross between the common butternut and the Persian or so-called English Walnut. (Figure 1.)



Black Walnut (*J. nigra*)
Butternut (*J. cinerea*)

Persian Walnut (*J. regia*)
James River Hybrid Nut

THE HYBRID AND ITS POSSIBLE PARENTS.

Merely from an inspection of the product, one is quite ready to admit that the Persian or English Walnut was one of its parents. The appearance of the nut itself does not give any safe indication as to whether the other parent was the black walnut or the closely allied butternut; but by a comparison of the leaves, and of the pubescence of bud-sticks, Mr. Bisset decides in favor of the latter. Second generation trees are now being grown, and as soon as they begin to bear, the problem should be settled beyond dispute. (Figure 2.)

section of the nut it appears as if the many fine lines, or divisions, of cineria had become solidified in the nut of the hybrid, thus causing the thick, hard shell of the seedling.

There is a young walnut tree growing a short distance from the old one (not over 150 yards away), which is said to have been raised from a seed borne by the old tree and planted about 1860. This is about the same height as the parent tree, and has a trunk about two and one-half feet in diameter. Its habit of growth, leaves, trunk, and bark are similar in every respect to that of the parent tree, with the single exception that the young twigs are heavily covered with pubescent hairs, which it would seem to have inherited from the butternut parent (*Juglans cineria.*)

Neither of the trees are prolific bearers, and what nuts they do bear seem to be of extremely low vitality, as so far we have not been able to learn of any other seedling trees being grown from them. The low vitality of the seeds indicates a weakness that is not at all uncommon in hybrids.

Professor Asa Gray was at one time shown young fruits from the old walnut tree, which he at once identified as *Juglans cineria;* the shape of the nuts being elongated and sharp-pointed, as in that species; but much wider or thicker. It is but just, however, to say that no leaves accompanied the specimen sent Professor Gray, to help him in his identification.

There is one character in the leaves of the old tree that resembles nigra, namely, that the leaflets have the sickle-like form of that species. Notwithstanding this leaflet resemblance however, and taking into consideration all of the characteristics of the old tree, and specially those of the young one (which, I think, we may be permitted to call the second generation) the shoots or young twigs of which have reverted to, or developed, the pubescent hairs of cineria, I believe this walnut to be a cross between regia and cineria, as before stated.

Now as to the value of this tree and similar hybrids, many have feared that, owing to their rapidity of growth, there would be danger of the scion overlapping the stock, and a poor growth be obtained as a result. Experiments being carried on at the present time in California, in grafting hybrid walnuts on the native California Black, have shown that the scion of the hybrid stimulates the stock itself to a more rapid growth and, therefore, we may find that the rapidity of growth of the hybrids will present no difficulties to the successful propagation and utilization of these hybrids for lumber production.

The soil upon which these two trees are growing is an alluvial, rich, sandy loam, of great depth, a soil well suited to the best development of the walnut tree.

In spite of this evidence, some of my friends are inclined to doubt the hybrid origin of this tree and to think it probably an aberrant form of the English walnut, as it is a well known fact that this species presents many variations or forms which yield nuts with all kinds of shells varying from that of the paper-shell variety, that can be easily crushed between the fingers, to the hard, thick-shelled varieties that are used so extensively in Germany and Switzerland in making small toys—the toys being carved out of these nuts. If the nuts borne by this tree were of greater vitality we would soon be able to determine without a doubt the parentage of the tree, for the young seedlings would show in their leaf characters the usual variation of seedlings from hybrids, but owing to this low vitality of the seed, it will, I am afraid, be some time before we can definitely decide upon the parentage of the tree.

MARRIAGE SELECTION

Contribution of Superior People to the Race Much Diminished by Present Educational System—Men Must be Made Independent Earlier and Women's Colleges Made Co-educational—Motherhood Should Receive Greater Honor and Cynical Sex Teachings Be Avoided.

Roswell Hill Johnson,
Professor of Biology and Geology, University of Pittsburgh, Pittsburgh, Pa.

THE great principle of natural selection still furnishes the chief motive power of evolution, even though nowadays we believe the lines are largely determined by the nature of the variations which appear. Now, in the study of human evolution at least, it becomes necessary to distinguish three distinct kinds of natural selection, for our social agencies affect these three kinds differently. These are lethal selection—that which operates by differential mortality; sexual selection—that which operates by differential success in mating; and fecundal selection—that which operates by differential fecundity. Today it is sexual selection, differential success in mating, that I am to discuss under this title of Marriage Selection. We may call it marriage selection, inasmuch as the extra-marital relations are largely sterile, for one reason or another, which we need not here analyze.

Sexual selection in man has one sharp distinction from that in the inferior species. In the latter, because of the larger rôle of instinct and the lesser rôle of social regulation and judgment, nearly all the individuals mate. There are very few unmated females and very few unmated males, except in species having severe male combat, when matelessness is the result of defeat. Where combat prevails, the main result of sexual selection is to cause a disparity of size and strength between the sexes and to accentuate bodily weapons, such as horns, canine teeth, spurs, and the like.

Since the disparity of size and strength between the sexes in man is no greater than that in the anthropoid apes, there is no evidence that male combat played a large rôle in the dawn-man. Indeed, the great reduction in the canine teeth indicates that combat has played a smaller rôle as time has passed, and fortunately so.

COULD NOT OPERATE ALONE.

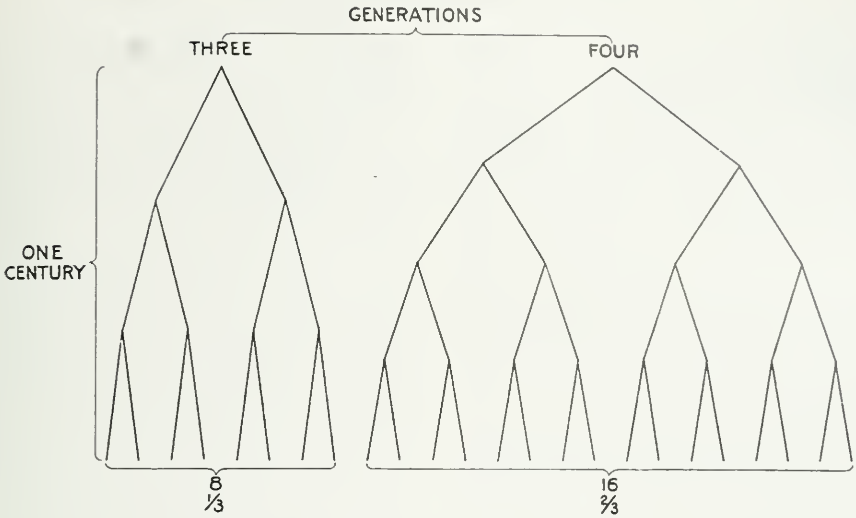
Sexual selection in primitive man, as soon as individual combat was reduced, operated very slightly, if unaided. Its effectiveness depended largely upon the co-operation of lethal and fecundal selection. Thus in warfare, the males of the defeated tribes were frequently killed, and the females taken as additional wives. Or, even when all eventually mated, some, who possessed a specially desirable characteristic to a higher degree, were chosen earlier and thereby had more progeny, or they were chosen by the superior, whose progeny would in some cases inherit a greater viability.

It is very probable that many of our esthetic attributes, such as musical and artistic ability, which are difficult to account for by lethal selection, have been produced by sexual selection.

In modern man we have the contrast of an unprecedented number of unmated individuals. This condition has developed with the growth of romantic love, which is the exclusive preference for a very long period for one mate over all others. As Finck has pointed out, this has been very much accentuated from the time of Petrarch on.

Now if these unmated individuals

Address made before the National Conference on Race Betterment, Battle Creek, Mich., January 12, 1914.



THE EFFECT OF LATE MARRIAGES.

Given a population divided into two equal parts, one of which produces a new generation every 25 years and the other every $33\frac{1}{3}$ years, the diagram shows that the former group will outnumber the latter two to one, at the end of a century. The result illustrated is actually taking place with various groups of the population of the United States. For economic reasons, many superior people are postponing the age of marriage. The diagram shows graphically how they are losing ground, in comparison with other sections of the population which marry only a few years earlier, on the average. It is assumed in the diagram that all persons in the two groups marry, and that each couple produces four children. (Figure 3.)

differ from the others in any important respect, sexual selection is very important. Or if we can alter the percentage of the unmated in different classes, sexual selection may become very potent.

It is obvious that the innately mediocre individuals are most numerous, and that both the markedly superior and inferior by nature are far less common. I mean by superior those who are individually happier and socially more useful than the average. The mental characteristics, at least in such a category, are too complex for a unit character treatment, even if such superiority is built up by unit characteristics.

WHY MEN DO NOT MARRY.

We must consider then what causes the failure to mate and what is the quality of each of these classes. Taking the men we have:

1. The cultivation of a taste for sexual variety and a consequent unwillingness to submit to the restraints of marriage.
2. Infection by venereal disease.
3. Pessimism in regard to women from such experiences.
4. Deficiency in normal sexual feeling or perversion.
5. Deficiency of one kind or another causing difficulty in getting an acceptable mate.

The persons in these five groups are, as a class, inferior. This inferiority is in part innate and in part the result of bad environment. But since innate inferiority is so frequently a large factor, we can conclude that the group as a whole will average innately inferior.

Then there are two other classes, largely superior by nature:

6. Those who seek some other end so ardently that they will not make the necessary sacrifice in money and freedom to marry.
7. Those whose likelihood of early

marriage is reduced by a prolonged education and apprenticeship.

We see that the action of sexual selection in regard to males, while favorable in some ways, is in great need of improvement. Such efforts may be made along three lines.

MEANS OF IMPROVEMENT.

1. Try to lead all young men to avoid a loose sexual life and venereal disease. A general effort will be heeded more by the superior than by the inferior.

2. Hold up the rôle of husband and father as particularly honorable, and proclaim its shirking, without adequate cause, as dishonorable. For a man to say he has never met a girl whom he can love, simply means he has not diligently sought one, or else he has a deficient emotional equipment, for there are many, surprisingly many, estimable, attractive, unmarried women.

3. Cease prolonging the educational period past the early twenties. The professional schools in our country are steadily delaying the age of graduation and thereby that of marriage. They formerly asked for High School training, and many still ask no more. But other schools have demanded more and more, till now one requires a collegiate bachelor's degree for entrance. The situation is made still more serious for medical students by the frequent postgraduate hospital practice without pay. It is time to call a halt. This cannot go on without serious loss to the race. Our young men should not have their marriage postponed by external circumstances past 25 years. This means we must allow students to specialize earlier. If there is need of limiting the number of candidates, let us have competitive entrance examinations. We *must* have our superior men marrying earlier, even at some cost to their early efficiency. The high efficiency of any profession can be more safely kept up by demanding a minimum amount of continuation work in afternoon, evening or seasonal classes, laboratories or clinics. No more graduate fellowships should be established till those now existing carry a stipend adequate for marriage.

WHY WOMEN REMAIN SINGLE.

Now we come to the consideration of sexual selection in women. Are the unmated inferior?

We do find some inferior individuals, such as those unattractive in manner and appearance, wholly as the result of poor health. This may be either inherited or else the result of ignorance frequently due to mental inferiority. Others are unattractive because of the absence of all sex feeling, or of some physical abnormality. And still others are unmated because they have fallen into ways of loose living, some as the direct result of innate defects such as feeble-mindedness, unusual susceptibility to suggestion, or sexual hyperesthesia.

On the other hand, when we have passed these groups of women, we find large groups that are distinctly superior. Some of these have had their chance of marriage reduced by going to women's colleges, others through engaging in preëminently feminine occupations, such as the teaching of children, yielding meagre opportunities to associate with men, or others through living in those cities that have an undue proportion of women. Then there are besides these, superior women who, because they are brought up in families without brothers or brothers' friends, are so unnaturally shy that they are unable to become friendly with men, however much they may care to. There are still others who repel men by a manner of extreme self-repression and coldness, sometimes the result of parents' or teachers' overzealous efforts to inculcate modesty and reserve, things valuable in due degree, but bad in excess.

In order to present to you the seriousness of the situation I attach the results of a study made by my student, Miss Helen D. Murphey. This deals with the graduates of Washington Seminary, in Washington, Pennsylvania, a secondary school for women founded in 1837, greatly antedating the first woman's college which opened in 1865. You will

see[1] that the marriage rate has declined. The drop in the '60s is due to the Civil War. You will also notice that the percentage engaged in occupations other than housewifery has increased progressively. It is not clear which of these occurrences is causal.

BIRTH RATE ALSO LOW.

The ominousneess of this declining marriage rate is aggravated by the low birth rate which these same women are found to contribute. Now combining these results to get the birth rate of the graduates as a whole, we have a most discouraging result.[2] Notice that only the earliest classes, with one or two exceptions, have enough children to reproduce the class. And this is not a college, and is not in New England, but in the same small city as Washington and Jefferson College, a much larger institution for men. If then under these favorable conditions, the marriage rate is so low, and marriage is so late,[3] we may infer that the low rate is widespread.

Let us now examine some of the results thus far attained in a study of Wellesley College data, made by my student, Miss Bertha Stutzmann.

Taking the Wellesley graduates of the classes 1905 to 1912 inclusive, it was found that 19.1 per cent. of them were already married in the fall of 1912, when the facts were collected. But for graduates whose scholarship was sufficiently high to entitle them to membership in the honor society, Phi Beta Kappa, the ratio of marriage to that of those who did not make this society was as 15 to 19. In other words, high scholarship in college women is (in this case at least) not found to be an aid to marriage, while in the normal school girls the opposite was the case.[4] It seems fair to assume that intellectuality in women is normally attractive to men, if these women do not neglect their social opportunities.

We see from this that the Wellesley alumnae have a very low marriage and birth rate. There is only one mitigating circumstance, that these women have married superior men. Out of the last 15 recently reported engagements which I noted, seven are to college or university alumni, although college graduates make up but about 1% of the whole population.

That college women are superior to the average woman is a safe inference. However, we may use another criterion of superiority. Eminence may be measured by space in collective biographies.

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[1]The relation between the decline of the marriage rate and the number of women entering professions is shown by the following figures taken at five year intervals, where A represents the percentage married and B the percentage who have gone into some occupation other than home-making:

	'45	'50	'55	'60	'65	'70	'75	'80	'85	'90	'95	'00
A	78	80	74	75	67	63	72	63	59	56	57	58
B	20	14	13	20	12	14	19	17	30	26	30	39

[2]The figures, summed at periods of five years, are as follows, when A represents the years in which the women graduated, B the total number of graduates, C the total number of their children and D the number of children per graduate:

A	'45	'50	'55	'60	'65	'70	'75	'80	'85	'90	'95	'00
B	46	86	101	98	69	62	43	98	113	100	117	108
C	146	150	152	73	81	70	59	122	130	83	131	75
D	317	175	151	74	118	113	137	124	115	83	112	69

[3]A graph plotted to elucidate this point shows that a large majority of the women marry four or five years after graduation, but the number of those marrying after 10 years is not very much less than that of the girls who become brides in the first or second year after graduation.

[4]In this same tabulation, it was found that the alumnæ of Wellesley College who were members of Phi Beta Kappa had an average of .065 of a child, each, while the rate for the girls who had not attained similar distinction in scholarship was .085.

Miss Castle's figures[5] show a correlation of eminence with a very late age at marriage and a consequent decreased racial contribution.

DELAY IS SERIOUS.

The objection has been made that eugenists are too much disturbed by this late marriage of superior women. To postpone marriage seriously reduces the likelihood of marriage. The critic says that late marrying women will have their children closer together and so eventually have as many. But the facts as collected by Miss Smith do not bear this out. Furthermore, the late marriage of superior persons cuts down their contribution to the race stream, because the years of fertility left to the wife are reduced. (Now that the average of human life is prolonged, the climacteric seems to come on startlingly soon to many of these late married women). Again, late marriages are relatively ineffective because of the lengthened generation. Suppose a generation to be 25 years or 33 1-3 years respectively in two different stocks, and that all persons marry and each couple have four surviving children or two per parent. The result (fig. 3) is that the 25-year stock constitutes two-thirds of the population at the end of a century.

Is it not imperative that something be done to raise the marriage rate of all superior women? To this end we must dissuade superior men from shirking marriage. If these superior men would keep their sex records clean, they would not suffer the severe depreciation which they do sustain in the eyes of superior women. But let us not take that ambiguous shibboleth "the single standard of morals" to mean a general sex strike, that is, ostracizing every man who has had illicit sex experience. This is too extreme. Early offenses where infection did not occur or has been positively cured, though properly considered a severe drawback, should not be perpetually condemning when followed by reform and real love. Such an unforgiving and uncompromising position can not be approved, because it leads a very large number of women into celibate lives, with a serious dysgenic result. In addition it increases the temptations of the men left unmarried. These extremists must remember that it is hard to get men to marry at even a normal rate, as current statistics abundantly prove. Therefore, the threat of a sex strike will never enforce chastity. Slow and hard as it is, we must content ourselves to build up a sounder moral basis by better attested methods.

HONOR FOR MOTHERHOOD.

Inappreciation of wifehood and motherhood by misguided feminists must cease, and greater honor and appreciation must be meted out to mothers, in order to more than compensate for the recognition that women earn in rival occupations. Women should

[5]The following table from C. S. Castle (Statistics of Eminent Women, in Pop. Sci., Mo., June 13) shows the age at which eminent women in history have married:

Century	*Average Age*	*Range*	*No. of Cases*
12	16.2	8–30	5
13	16.6	12–29	5
14	13.8	6–18	11
15	17.6	13–26	20
16	21.7	12–50	28
17	20.0	13–43	50
18	23.1	13–53	127
19	26.2	15–67	189

It is to be noted, furthermore, that if the American women of the 19th century in this table are separated, their average age at marriage is found to be 27.7 instead of 26.2.

Thorndike's statistics on marriages among college women (1901) show that:

45 per cent. of college women marry before the age of 40.
90 per cent. of all United States women marry before the age of 40.
96 per cent. of Arkansas women marry before the age of 40.
80 per cent. of Massachusetts women marry before the age of 40.

In Massachusetts 30 per cent. of all women have married at the age at which college women are just graduating. (Marriage among college women. Outlook, October 5, '01.)

properly be permitted to do any work they wish, not incompatible with their well-being; but *greater* honor and esteem is due those who have not shirked the paramount function and responsibilities of motherhood.

While waiting for separate colleges to become co-educational, as they eventually will, their present dysgenic tendency can probably be reduced by the gradual introduction of men teachers into the women's colleges. Women professors tend to foster celibate career-hunting, which, attractive as it is to many young women at first, in most cases is eventually unsatisfying. Furthermore, the introduction of courses dealing with the home and the child would give college women increased interest in and eagerness for that noblest profession of home-making and motherhood.

Let us not err in our efforts to teach chastity by making sex appear an evil thing. This is a terrible mistake and all too common. One of my students, referring to a widely read sex book for young men, said one would infer from it that all married men suffer a serious sacrifice in health. I am confident that much of the celibacy of women may be blamed to ill-balanced mothers and others who, in word or attitude, build up an impression that sex is indecent and bestial, and engender a general, damaging suspicion of men.

CAUTION IN SEX EDUCATION.

It is necessary to keep our heads level in the sex ethics campaign. The venereal diseases will probably, if we can continue our present progress in treatment and prophylaxis, be brought under control in the course of a century, while the problem of differential mating and the fecundity of the superior stocks will be with us as long as the race lasts, which we may expect to be tens of millions of years. Let us not present too luridly, by drama, novel, or magazine story, dramatic and highly-colored individual sex histories. These often impress an abnormal situation on sensitive girls so strongly that aversion to marriage or sex antagonism is sometimes aroused.

The facts should be presented in a more dispassionate, scientific, proportioned, and psychologically sound way —not by cynics, but by competent, experienced, sweet-minded persons.

Eligible young people should have their circle of acquaintances broadened. Co-education,[6] I believe, is one of the best means, as associating the best groups. But many other means should be encouraged. We have in this a further justification of cards, dancing and theatres. That these may sometimes be pursued intemperately need not condemn them universally. These and other social devices extend the range of acquaintance, and also give the necessary time for mutual estimates and friendships. Others besides parents should feel some obligation to afford these social opportunities to young people. Surfeit for some individuals and dearth for others calls for curtailment here and encouragement there.

SELECTION CAN BE IMPROVED.

I now pass to the consideration of the objection so frequently heard that the selection of mates in man cannot possibly be improved, because it is wholly a personal and capricious thing. But the objectors on this score ignore the fact that three mental stages are normally passed through in this mate-

[6]The following figures by Shinn (Marriage of college women. Century, October, 1895) show the marriage rate of college women, assuming graduation at 22 years of age:

Women Over	*Co-ed.*	*Separate*
25	38.1	29.6
30	49.7	40.1
35	53.6	46.6
40	56.9	51.8

Marriage Rate from Co-ed. Colleges in Nor. Atlan. 29.0; Mid. West 33.6.
Women in general marry most frequently at 20–25 years of age.
College women marry most frequently at 25–30 years of age.

choosing process. They fall into error by concentrating attention on the last, most obvious, emotional, "love-is-blind" stage. The first involves the broad determination of our associates. The second is the narrowing of choice to those whom we specially admire and elect as friends. The last is the actual "falling in love."

One of the chief factors in this first stage is the structure of the social unit to which we belong. How frequently matings are determined by the school, church, or neighborhood! Then there is another group, composed of our parents' chosen friends, with whose children we are naturally thrown. The mother who sends her girl to the university rather than into the *thé dansant* set, determines largely the type of her daughter's fiancé, not only because her associates are different in the two cases, but because the girl's ideals will be differently built up. The young man who goes with fast girls is indirectly determining the kind of girl he will marry —if, indeed, he is not thereby led to abandon marriage. During this second stage of more intensive associations or friendships, there is clear-headed discrimination, before the emotions have become imperious. I believe that the period of mere friendliness is longer in most cases than the period of conscious loving before marriage. So we see the choice of a mate is not ordinarily capricious.

ASSORTATIVE MATING.

To show you that marriage selection does really operate, I have collected in a table the cases so far observed showing assortative mating[7]. This may be defined as the degree to which like mates with like. This does not have as great a eugenic significance as preferential mating, but the latter has not yet been so well demonstrated. Assortative mating has the value, however, of building up the unusually able brains the world needs. In this table 1 expresses perfect assortative mating, that is, each degree always mating with the corresponding degree. O expresses random mating. You will notice in the royal families that assortative mating is low because interfered with for state reasons.

My student, Miss Carrie F. Gilmore, has found a preferential mating in facial appearance and class marks.

Thus in the class of 1902 of the Southwestern State Normal School of Pennsylvania, where the marriage rate of graduates is 43.7 per cent. (status in 1912), it is found that the marriage rate among the girls who got marks of 90 or over in their studies is about 56 per cent.

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[7]ASSORTATIVE MATING.

1 = complete.

Trait	*Investigator*	*Index*	*Probable Error*
Stature (Eng. Mid. Class)	Pearson-Galton	+.09	+.04
Stature	Pearson	+.2804	+.0189
Age	Lutz	+.75	+.
Cephalic Index	Boas	+.15	+.10
Deafness	Schuster	+.90	+.
Normality (Fam. With Crim'ls)	Goring	+.11	+.
Longevity	Warren et al	+.22	+.02
Intelligence	Elderton et al	+.33	+.
Temper	Elderton et al	+.18	+.
Excitability	Elderton et al	+.11	+.
Sympathy	Elderton et al	+.15	+.
Reserve	Elderton et al	+.27	+.
Success in career	Elderton et al	+.48	+.
Insanity	Elderton et al	+.30	+.05
Intelligence (royal)	Woods	+.80	+.076

Preferential mating is also indicated in the data[8] regarding college women and their non-college sisters, cousins, and friends as collected by Miss M. R. Smith.

FORCE OF PUBLIC OPINION.

Marriage selection is under some degree of legal control through marriage and divorce laws. Those who maintain that mating is wholly capricious forget the very considerable extent to which social control has made itself effective in the past. Indeed, many of the prohibitions are now relaxed, such as the notorious deceased wife's sister provision. It is obvious that marriage laws should make as few restrictions as possible without strong reason. A minimum age and a high degree of consanguinity have been an almost universal matter for legislation or enforced custom.. And let it be noted, their object has been primarily eugenic. A relationship closer than that of cousin should constitute a prohibition. Yet cousin marriage need not be denied except in the event of that branch of the family, common to the cousins in question, having individuals with certain specified defects. The suggestion that proposed cousin marriages should be passed upon by a state eugenic board, although biologically sound, does not seem so from the sociological standpoint. In case of an adverse decision, there would follow either broken hearts or a liaison, for the hope of a favorable decision would have engendered a strong attachment. Freedom from venereal disease—at least for men—must be attested to by competent physicians by competent tests, the state assuming a share of the financial burden. It does not seem wise, however, to demand freedom from all mental and physical defects, for if the defect is very serious, a surer method must be employed than the withholding of a marriage license. If it is less than very serious and not pernicious, we are not justified in prohibiting marriage, provided it is the earnest intention of the couple not to reproduce. In the event of such a marriage proving fertile, sterilization would prevent a second offense.

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[8]COLLEGIATE ALUMNAE DATA, 1900.

M. R. Smith, Statistics of college and non-college women. Pub. Amer. Stat. Assn., VII. p. 1.

Percentage of Married	*College*	*Equivalent Non-College*
Under 23 years	8.6	30.1
23–32 years	83.2	64.9
33 and over	8.0	5.0

Age at Marriage:
- 26.3 college
- 24.2 sisters
- 24.7 cousins } 24.3 (sisters, cousins, friends)
- 24.2 friends

	No. of Children	*Per cent. Childless at time*
College	1.65	25.36
Equiv. Non-Coll	1.875	17.89

Occupations of Husbands per cent.	*College*	*Where Wife is Equiv. Non-College*
Col. Teachers	65.9	51.4
Other Teachers	23.3	11.8
Lawyers	15.7	11.2
Physicians	9.0	8.6
Scientists	2.0	0.6
Clergymen	7.0	4.8
Artists	0.9	0.3

Income of Husbands	*College*	*Where wife is Equiv. Non-College*
Less than $2,000	24.5	36.7
$2,000 to $5,000	46.5	44.1
Over $5,000	27.1	16.9

Miscegenation of certain races may properly be controlled as far as possible by the refusal of marriage licenses and by public opinion. This will unfortunately result in cases of individual injustice, but is nevertheless racially necessary. The proposition to refer doubtful cases of mixed blood to the state eugenic board is objectionable, for the same reasons as above.

THE DIVINE QUESTION

While society may deny the right to marry only for grave cause, it should be glad to divorce pairs whose progeny are not desirable. This for the reason that in one case society is acting against the will of the two parties. In the second case both the two parties concerned and society profit by the divorce. Divorce is far preferable to separation, since the unoffending party should not be denied the privilege of remarriage, as the race in most cases needs his or her contribution to the next generation. Divorce, it must be remembered, is ordinarily just a legal recognition of a separation that already exists. The time-honored and justifiable grounds of adultery, sterility, impotence, venereal infection, desertion, non-support, and habitual cruelty are no more worthy of legal recognition than the cacogenic grounds of drunkenness, feeble-mindedness, epilepsy, insanity, or other specified serious mental, moral, or physical defects.

For sexual selection to work at its best, it is desirable that the mated persons be as superior as possible to the unmated. Is it not, then, a social blunder to deny divorce to a married pair, if one of them at least is inferior? We hear much of a divorce evil but we have in reality a divorce remedy for the evil of ill-mated pairs.

Dysgenic marriage we can not prevent as frequently as would be desirable, because we have not the co-operating will of the couple. When, in such undesirable marriages, the individuals come to see their mistake, society should gladly welcome the prompt undoing of the marriage bond.

In closing let me urge you to do all in your power to correct this growing tendency to postpone if not to abandon marriage entirely, on the part of our superior young people. Hold out marriage as one of the ends of a useful, normal, beautiful life. Help superior young people to meet, and encourage and further their *early* marriage. Give more honor and appreciation to those who have married well and have had adequate children. And in whatever ways you properly can, reduce this appalling percentage of superior celibates who are thus pulling down the quality of the human race.

ANNUAL MEETING OF ASSOCIATION

The annual meeting of members of the American Genetic Association was held in the Cosmos Club at Washington on January 8. The secretary reported that more than 200 new members had been received during the last year, in spite of the fact that the work of the association was suspended during the greater part of the year. The membership on the first of January was 1837, of whom, however, 313 were delinquent in their dues. The membership at the present time is increasing at the rate of more than a hundred each month. The number of foreign members is increasing with exceptional rapidity.

The treasurer's report showed that expenses of the year had just about been met by the income, leaving the guarantee fund intact, to meet the increased expenditures due to the publication of the magazine as a monthly.

The council for 1914 was elected as follows:

One-year term: Alexander Graham Bell, W. E. Castle, Bleecker Van Wagenen.

Two-year term: O. F. Cook, David Fairchild, Arthur W. Gilbert.

Three-year term: George M. Rommel, T. H. Kearney, W. C. Rucker.

At the annual meeting of the council, the present officers were all re-elected.

President Fairchild announced the make-up of the research committees for 1914, as printed on the back cover of the present issue of the Journal.

SEEKING PLANT IMMIGRANTS

Explorations in Asiatic Russia, in Search of New and Valuable Plants Suitable for Introduction to the United States—Desert Flora not Rich in Species—Small Forests Established in Pure and Moving Sand—Fruits Mostly of Commonplace Character—Trying Conditions of Work.

FRANK N. MEYER

Agricultural Explorer, Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry, United States Department of Agriculture, Washington D. C.

Although plant breeders realize in a general way that new material is constantly being furnished to them, and that new crops from time to time make their public appearance and assume a prominent place in our agriculture, while old ones are frequently being improved by the spread of newer and better forms, few understand in just what way these new plant immigrants are secured. It has seemed, therefore, that an account of some of the work done in Asiatic Russia by an American citizen of Dutch birth, Frank N. Meyer of the U.S. Department of Agriculture, would prove of great interest to American plant breeders, while his graphic pictures of these semi-civilized countries are certain to attract the general reader as well. The following article is made up solely of extracts from Mr. Meyer's letters to his chief, the scientific names being in the form used by him and not neccessarily the form accepted by the botanists of the Department. The illustrations are all from his original photographs—The Editor.

ASKABAD, TURKESTAN.
June 7, 1910.

WELL now, you'll no doubt be interested to know how I got into Central Asia. We left Baku on Monday night, May 30, and landed the next afternoon in Krasnawodsk, where we found a few police officers and gendarmes asking us for our passports. My name had been booked already for months and I was informed that all my requests to explore and photograph had been granted and that the various authorities had been instructed to assist me. On June 1, I received my passport back and left in the afternoon for Kizil-arwat, where according to my interpreter's belief many rare Persian seeds could be obtained. When we arrived there the next day, we didn't find it to be so, as most of the Persian population had shifted to Askabad and Baku. In the afternoon we left again for Bachar-den, a small town near to the mountains, where some fine native vegetation was said to occur.

To obtain a cart consumed the whole next day (June 3) but we left at four o'clock in the morning of June 4. Our cartman, a conceited Armenian, professed to know the country, but—at eight o'clock we were quite at a loss where we were and we camped in the open. On June 5 we found a soldiers' post, for we were close to the Persian frontier, and made our headquarters there for that day and on June 6 we returned again to Bachar-den. I found some interesting plants during these days; an ornamental Eremurus, a few species of Tamarix, an Acer, *Cerasus microcarpa*, Prunus sp., Rhus sp., interesting grasses, etc. We made a goodly pile of herbarium material which will reach you in due time.

WILD MAPLE OF TURKESTAN.

This unidentified species of Acer grows on the hottest, dryest and most arid slopes of the mountains of Bachar-den, at elevations of 5,000 feet and over. Its small leaves vary widely in shape, all forms being found from tri-lobed to entire. It probably has some value as an ornamental in the most severe parts of the southwestern United States. (Fig. 4.)

PRUNUS MICROCARPA AT HOME.

Central Asia contains many varieties of hardy plums, some of which are already valuable commercially, while others offer most promise as stocks on which to graft improved varieties for propagation in desert regions. Even in their wild state, the fruits are prized by the natives of Turkestan, and with a little cultivation they are considerably improved. This photograph of *P. microcarpa* (standing in the center of the picture) was made on June 4, 1910, in the mountains of Bachar-den, Russian Turkestan. (Fig. 5.)

IMPRESSIONS UNFAVORABLE.

I cannot say that my first impressions of Central Asia are so very pleasant, after having seen so much of the beautiful Caucasus. There is much heat, much dust, much vermin here, and relatively little comfort—even washing water is hard to get. The vegetation too, is, as could be expected, not very varied in general. Around the houses and railway stations one finds mostly our Acacias (*Robinia pseud-acacia*), *Ailanthus glandulosus*, *Ulmus pumila*, *U. campestris*, *Populus bolleana*, *Sophora japonica*, *Koelreuteria paniculata*, *Morus alba*, *Gleditsia triacanthos* and here and there an Osage Orange (*Toxylon pomiferum*) All those trees are periodically irrigated. If not, they die within one or two years. In Krasnawodsk, however, where it is quite mild in winter, I noticed a beautiful flowering bush, *Poinciana gilliesii*, which thrives with very little irrigation; *Elaeagnus angustifolia*, *Populus diversifolia*, and a species of Saxaul-bush (*Ammodendron*?) also need very little water. There are, however, apparently few trees to be found that resist the aridity of the Central Asian plains, where hot summers are followed by cold winters, while high winds blow very frequently both winter and summer. The trees that looked the best are the native form of *Ulmus campestris*, the Chinese *Ailanthus glandulosa* and the North American *Robinia pseud-acacia*.

ALFALFA FROM THE MERW OASIS.

An enormous trade in alfalfa seed has been created in Turkestan, since the merits of the varieties native to that country were advertised by American explorers. South America takes a larger quantity than does the United States. According to Russian experts, the Turkestan alfalfa is somewhat short-lived, but this has not prevented the annual export of seed mounting to hundreds of thousands of pounds each year. The trade has proved decidedly profitable to the natives, since their camels will readily eat the alfalfa even if it is somewhat damaged by threshing. (Fig. 6.)

SHORE OF THE CASPIAN SEA.

Various species of Tamarix, woody Chenopodiaceae and other salt-loving plants grow fairly luxuriantly. These Central Asian tamarisks promise to have some value for the desert of the south-western United States, as they grow vigorously even in moving sand, binding it together, and furnishing a fuel supply to desert dwellers. They often grow in soil of which the surface is covered by a thick, white deposit of alkali, and many species produce attractive flowers. Photographed at Krasnawodsk, Turkestan, June 1, 1910. (Fig. 7.)

AGRICULTURE IN SAMARKAND.

SAMARKAND, TURKESTAN,
June 27, 1910.

Alone in Samarkand! My assistant got tidings from home yesterday that his presence was urgently needed, as the man in charge of his farm was severely injured by a horse, and he left me. The interpreter had left the day before, as his eyesight and general health had become rather bad these last days on account of the great heat, and so it has come to pass that I am left alone in this far-away land, with only a mere smatter-fog of Russian and no knowledge at all in the Sart language, which is much spoken here. I'll get out of it, however. We found a German, who may be willing to go with me; his looks, however, didn't please me, and to go with a stranger in some out-of-the-way places, with the necessarily large amount of money I generally have with me, is not a safe proceeding.

Well, my last letter was from Askabad, dated June 9, 1910, and it was again a holiday, of which the Russians only keep about thirty-eight a year. The next day I went with the interpreter to the Experiment Station about four werst from the city. There wasn't much to see: some plots with cotton, some alfalfa fields, various beans and a tree-nursery, where somewhat more

DESERT POPLAR OF TURKESTAN.

Populus pruinosa in the city park at Krasnawodsk. Although it is difficult to propagate, this tree is highly desirable for desert regions, as it needs almost no water. The wood is hard and lasting, but it does not attain great size. (Fig. 8.)

weeding could be indulged in without any harm.

On Saturday, June 11, we wanted to leave early, but I got a message from the police to appear before them. Something new, I thought. Well, we went and the whole thing was nothing but a curiosity to see me. The captain, or whatever his rank was, asked my interpreter whether I really was a botanist, whether I only had interest in plants, and more such suspicious questions. He then told us that permissions had come from St. Petersburg, allowing me to photograph trees and plants only, and that for every locality I wanted to visit, I had to get a special permission either written or verbal, depending upon the importance of the place. But —under no consideration would I be granted permission to go to the Afghanistan frontier, as foreigners were not allowed! Well, I knew already most of these matters, having made enquiries beforehand. We thanked the police-officer kindly and I was glad to have my passport back again, which they had kept all the time I was in Askabad.

ARRIVAL AT MERW.

We left the same day for Merw, where we arrived after midnight. The next day, June 12, was exceedingly hot, and the light so intense as to make one almost dizzy. We took out the collected herbarium material, which wasn't all dry yet, and gave it an airing —much trouble herbarium material causes on a journey! In Merw there is a pretty park, where tall specimens of poplars occur (*Populus alba pyramidalis*). I also saw there for the first time in my life some fine large specimens of the "Karakach" (*Ulmus campestris*

IN THE CITY PARK AT MERW.

The most conspicuous trees, and the ones best adapted to arid portions of the United States, are the white poplar (*Populus alba bolleana*) in the center, and the Karakach (*Ulmus campestris umbraculifera*) at the right. The white poplar is the principal lumber tree in Turkestan and is widely planted, the trees being sometimes no more than five feet apart. They are free from disease and grow rapidly, even on rather alkaline soils. It can be pollarded successfully. The species is doubtless native of Chinese Turkestan, and is therefore thoroughly accustomed to a severe desert climate. (Fig. 9.)

umbraculifera); very striking trees they are, with their umbrella-like shape and a dense mass of rather small foliage. These trees will be highly appreciated by our settlers in the desert regions. These elms, although drought-resistant, have to be watered. Other trees in that park are *Acer negundo, Robinia pseudacacia, Sophora japonica, Ailanthus glandulosa, Gleditsia triacanthos, Salix babylonica, Toxylon pomiferum, Catalpa bignonioides, Morus alba, Cydonia vulgaris, Prunus armeniaca and Pirus communis.*

A OERMAN SETTLEMENT.

On Monday, January 13, there was a great market held in Merw; Turcomans, Afghans, Kirghisians and many other wild looking inhabitants of these regions here, mingled through one another. The products that were brought in were mostly very poor, like the fruits and vegetables for instance. I bought some barley, millet and wheat, but found little new. In the afternoon we hired a cart and went to a German colony thirty werst northeast of Merw. The cultures are not in the pitch of perfection, as it is a rather new colony. The system of cotton-culture is as the Turcomans have it, viz., a field is divided into a number of square plots, each plot with ridges all around. The cottonseed is sown broadcast by hand and the plots are flooded whenever they get dry. Cultivation of the land is not much practised beyond keeping the weeds down.

Well, the results of this antiquated system of culture are: First, that the stand of the cotton is very irregular; second, much water is wasted by not cultivating regularly; third, by not sowing in rows, all of the weeding and cultivating has to be done by hand; fourth, in case of failure of water, as occurs often, the small plots of land dry out to such an extent, that the harvest becomes almost nil. The alfalfa fields, however, looked very nice and they found this useful plant their steadiest money-maker. In fruit and vegetable culture one could clearly see that time and knowledge were lacking. In general one has to sympathize with such German settlers who are willing to rough it in such far-away corners of the Russian Empire, where they, at the utmost, are able to become owners of small plots of land, without having any of the pleasures or culture of the more progressive races of men.

THE USEFUL CAMEL'S THORN.

The desert around Merw is quite interesting. The camel's thorn, *Alhagi camelorum*, covers tens of thousands of acres of land. It was in full bloom and its small pinkish-purple flowers, produced by the million, gave color to the landscape, just like the heath in northwest Europe does. This camel's thorn is a very useful plant here. Firstly, it is a great feed for the camels, who are said to love this plant better than any other wild herb. Secondly, it is mown, dried and used as a fuel. Nearly all of the bricks in the oases are baked through the heat of this plant. Thirdly, it is a great sand binder, growing even in pure, sterile sand and as it is leguminous, it prepares the soil, by enriching it, for better vegetation. As I move along I may find out still more about this plant.

Beside the camel's thorn there also grows a very spiny acacia-like plant, in the desert. It is not ugly as a solitary plant, but it is a bad weed on all untrodden places; some Lyciums I saw, too, and a few minor things, but as a whole the desert flora is not rich in species. One finds, however, in the desert around Merw many canals, some still in use, some dried up; they say that some of these man-made watercourses are 3000 years of age and, if so, there is surely "little new under the sun", so far as irrigation is concerned. The present people here have a great hope for the future as far as the bringing-under-culture of desert land is concerned. Large, new canals are being dug, new settlements started, and with present high prices of cotton, people can be comfortably off in some years time.

AT THE IMPERIAL ESTATE.

On June 16 we went to the Imperial Estate, "Murgab", where fine things were reported to exist. We looked at the very imposing avenues of the Karakach, saw the fruit-orchards, where the apricot trees were fully as heavily loaded as in California, saw the nurseries with fruit and ornamental trees of many kinds. There are a few varieties of apricots and of pears and quinces, that seem out of the ordinary and of which I hope to get scions or plants. Well, after we had looked around for a couple of hours we went back to the police again and this time found the chief himself, a tall, elderly, soldier-like chap, who had looked up all our references and had come to the conclusion that when St. Petersburg allowed me to take photos of trees and plants, there wouldn't be any crime committed if he also permitted me to do so, but to be on the safe side he gave a swarthy policeman to show us the beauties of the place

On Friday, June 17, we left Merw again for Chartchui, this time with the assistant, who had gotten his passports into shape. He is an honest fellow, who served his three years as a soldier, and loves the mountains better than the routine work of his little farm.

FOREST IN MOVING SAND.

On Saturday, June 18, we first paid a visit to the police where we were informed that, although photographing was allowed in Central Asia, this district was exempted from it, as it was in Bokhara, and the Political Agent in the city of Bokhara, alone had the power to give that permission. No wonder that

AVENUE OF KARAKACH TREES.

This fine row of *Ulmus campestris umbraculifera* was photographed on the imperial estate Murgab, at Bairam-Ali near Merw, Russian Turkestan, on June 16, 1910. The tree endures drought and a fair amount of alkali, and is as useful for shade purposes as is the umbrella tree (*Melia azederach*) so widely cultivated in desert portions of North America. Grafted forms of the Karakach are propagated by the rich in Turkestan, in order to ensure a solid head of shade. (Fig. 10.)

so few photographs of Central Asia are to be had, is it? Well, I then called on W. A. Palletsky, in charge of the sand-binding work along the railroad in Central Asia. I found him to be a most pleasant man who had a railroad trolley come before his house and off we flew over the imposing Amu-daria river, along whose level shores some of the world's finest melons grow, along sandy hill and plains, all planted with sand-binding plants until we were eight or ten werst out, where the plantations were the oldest. It is most interesting to see how the tall bushes of *Calligonum caput-medusae, C. arborescens, Salsola richteri* and *Haloxylon ammodendron* have grown into some sort of a forest in a soil that is almost pure sand and, worse than that, a moving sand! And stranger, even, to see how a few seeds of the Chinese Tree of Heaven (*Ailanthus glandulosa*) have found lodging between these real desert plants and have grown vigorously, too, and are of fairly good sizes now. Mr. Palletsky said the real Saxaul (*Haloxylon ammodendron*) is an aristocrat—in other words, it is not a plant one can plant straight away on a shifting sand. First other vegetation has to make the soil firm, after that the Saxaul will grow. To arrest a shifting sand-hill, one first has to plant various Calligonums, then *Salsola richteri* and after that *Haloxyon ammodendron*. Of the Calligonums there is an immense mass. Up to the present fifty-seven different species have been found, and there are still more. However, only thirty have been scientifically deter-

CITY PARK IN KRASNAWODSK.

The hedge in the foreground is *Poinciana gilliesi*, and the tall shrubs are *Ulmus pumila*. Both of these shrubs are valuable for arid climates with scorching summers and mild winters; the former has long been esteemed in the United States. Photograph taken at Krasnawodsk, Russian Turkestan, June 1, 1910. (Fig. 11.)

mined and the others will come in the course of a few years. Some of these Calligonums are strictly local plants and may not readily bear acclimatizing —at least Mr. Palletsky found that the species from around Oremburg and Astrakhan do not stand the long, intense heat at Chartchui.

WORK IN NURSERIES.

After having seen the large plantations, where the plants are now spreading rapidly and require practically no care any longer, we paid a visit to the nurseries where seeds are sown and young plants raised. They had experienced a very late frost and the stand of the plants was not what they wished it to be, still it was interesting to see how the sand was held in check by long straw stretched over it, this kept in place again by little sticks set across it at the ends. Hedges of Tamarix sp. and of the wild form of *Elaeagnus angustifolia* kept the great winds off. The seeds are all sown in the autumn and have to be kept moist as long as they haven't germinated; when once above the ground, however, great care is necessary in keeping them almost dry, as otherwise they perish.

Then Mr. Palletsky showed me with much pride an Opuntia cutting, which he had obtained from us through the St. Petersburg Botanical Garden, and which cutting was growing nicely. He was very grateful to have it, and had six more distributed at different points in Central Asia. But then we began to talk about lowness of temperatures here and he said that the minimum had been 14° Reaumur (Zero F.). Well, then, I said

that all of his spineless Opuntias would go, and even long before that, telling him of the experiences at San Antonio, where all the spineless forms of Opuntias froze when it was 12° Fahr.

EXPERIENCES IN BOKHARA.

Samarkand, Turkestan,
June 28. 1910.

As I said, I arrived in New Bokhara on Sunday afternoon. On Monday we went to the police for passport and photograph matters, but it was a holiday again and we couldn't do a thing, so we went to Old Bokhara and had a glimpse around. The interpreter pretended to know all about the town, but I found him to be misinformed, like I had experienced several times these last days, and his eyes had become so bad these last hot days that when he passed from the light into the shade we had to assist him, otherwise he fell into holes and ditches. So we returned in the evening without having seen the grain market or Mr. Parkinson.

The next day, Tuesday, June 21, we went again to the police and saw the Political Agent, a gentleman of shrewd appearance and possessing much power. He said that I would be permitted to travel in the Hissar Mountains in Central Bokhara and take photos of botanical subjects; he thought it, however, advisable that I shouldn't go alone and wishes me to have a Bokharian official go along, I having to pay him a salary and sustenance. My route of travel he also wishes me to send him.

I answered that I couldn't decide right on the spot how these matters will go, as I expected important mail in Samarkand and have to supply me yet with a tent and some more camping outfit.

That was all right, he said, he only wished me to know that Bokhara is not an easy country and travelling alone without a native of some standing would be extremely difficult. He also said I will not be allowed to go near the Afghanistan frontier, as no foreigners are permitted to go there.

PRODUCTS OF SART GARDENS.

In the afternoon we repaired again to Old Bokhara, took a droshky and drove to the office of Dürrschmidt & Co., where Ernest Parkinson, of the Reichardt Asiatic Trading Co., resides. We found him and William Donohue at home and had a long talk. The weather was very hot, 114° Fahr. in the shade, but Mr. Donohue went with us and showed us the grain market, the medicine shops and other points of interest. As it became late, however, we made arrangements to come back early next day. And so we did. Then Mr. Parkinson went with us, too; we bought some seeds, like wheat, cowpeas, hemp and poppy, and saw a real Sart garden where grapes, apricots, apples, pomegranates, quinces, peaches and figs were grown. The pomegranates and figs have to be buried, however, every winter, but still they bear fruits.

In general, from what I saw, I cannot say that there was much of interest to be found among the seeds and plants. They are apparently all well known. For fruits I am apparently somewhat early yet. Grapes are just coming in, but they are small and not very fine. The apples are greenish and, though ripe, of a very insipid taste. Apricots are small and apparently most times seedlings, though a few of fine, melting flavor are once in a while seen. The plums one sees now are those of *Prunus insititia* and perhaps also of *P. divaricata* and there is much variation among them, although the fruits are small. The muskmelons are just coming in and two kinds there are, the one greenish and generally split open and the other yellow ones, small in size, but of very sweet and melting flesh. I was assured that later in the season fine large plums and still better grapes and melons are coming, but that is a few months later.

Eugenics Not Impossible

There is nothing either in the history of domestic animals or in that of evolution to make us doubt that a race of sane men may be formed, who shall be as much superior, mentally and morally, to the modern European, as the modern European is to the lowest of the negro races.—Francis Galton: Hereditary Genius (1902).

TESTS FOR MENTAL DEFECTS

How the Public Health Service Prevents Contamination of Our Racial Stock by Turning Back Feeble-Minded Immigrants—General Characteristics Noted and Progressive Series of Tests Applied to Determine Exact Mentality.

HOWARD A. KNOX,
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BEFORE one enters upon a search for a thing he must know definitely what he is seeking, else the object of his quest may pass him unnoticed. This is even more true with regard to the various grades of mental enfeeblement than in the case of any physical infirmity because there still exists considerable chaos in the minds of many as to just what constitutes mental deficiency.

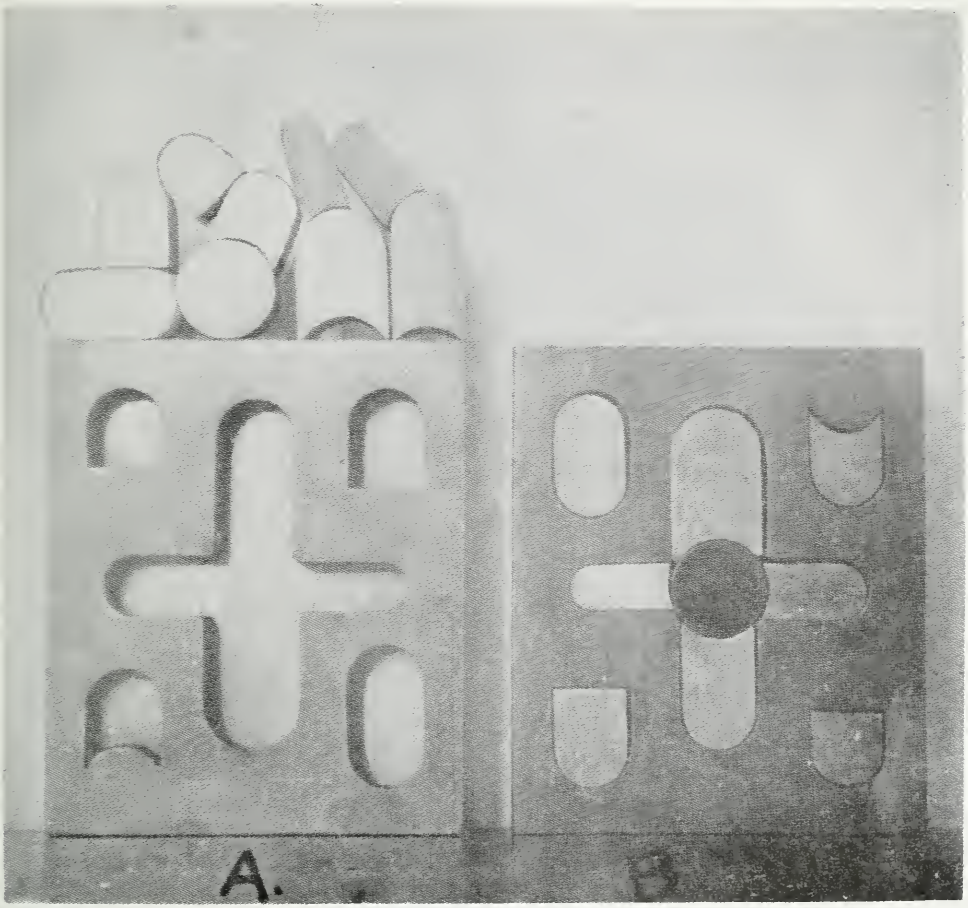
Some have attempted to formulate a social definition and hold that anyone, not actually insane, who is unable to reside harmoniously in the environment to which he is accustomed, and in compliance with its laws and customs, is defective mentally. This definition, while it includes many defectives, leaves out nearly all the potential ones and the majority of the higher ones that are not criminally inclined. Its application would necessitate turning all defectives loose in the world to see whether they can keep out of public institutions. This is exactly what some of the doctors and lawyers representing some of the immigrants would like to have done in the case of feeble-minded aliens who are detained at immigration stations. Fortunately the laws are such that feeble-minded aliens may be certified and deported before they have had an opportunity to contaminate the blood of the nation or to commit any crime.

The United States Public Health Service has worked laboriously and intensively to determine the standards of knowledge of the various races. The standard and definitions of feeble-mindedness are based on what a given subject can do, his previous environment, education and the stress under which he may be laboring being taken into account. In short, the tests are functional tests of the brain used in much the same way as functional tests are used to determine the amount and quality of work which the kidneys, for example, are capable of doing. The most successful test in use for the detection and classification of deficiency in educated children, namely the Simon-Binet Scale, is based on the same principle, that is, to learn exactly by experiment what normals can do with ease and to use the result of this work as a scale for weeding out defectives.

RECOGNIZING THE DEFECTIVES.

The public in the past has only recognized as defective those persons who are lacking in the intellectual sphere, in other words those who are stupid, dull and foolish. The emotional, volitional and criminal defectives have received scant attention. Yet, it is the latter, perhaps, who are the greatest menace. They are able to support themselves yet they are also able to reproduce the real old fashioned idiot and imbecile which the state must care for.

Now this being true, how may these potential inferiors be recognized? In the first place those who are themselves not markedly defective, but who are capable of transmitting weakmindedness to their progeny, usually possess facial peculiarities, temperamental queerness or both. For instance, as in the case of the frontispiece, the mother may possess many of the facial signs of a Mongolian defective and yet have no recognizable mental impairment. With a healthy husband who had a clean



THE "IMBECILE" TEST.

A normal six-year-old child can fit all the cut-out blocks into their places inside of five minutes, with not more than six false moves. All immigrants suspected of feeble-mindedness are asked to perform this and other similar tests; their exact degree of mental deficiency can thus be rated. For instance, if a ten-year-old boy requires five minutes to fit the pieces in this block, and makes half a dozen false moves, it indicates that he has only the mentality of a six-year-old. (Figure 12.)

family history, this woman produced a typical Mongolian imbecile child. This observation is so frequent that it is worthy of note. Temperamental peculiarities have been observed in the parents of defectives so frequently that these eccentricities are now regarded as the precursors of actual deficiency in the immediate or future descendants.

These peculiarities are cyclothymia (alternate periods of hilarious joy and deep depression), nerve storms, poorly controlled grief, temper yielding to minor excitations, untimely mirth, sensual morbidity and perversion, sullenness, facial tic and other minor neuroses, sick headaches, hypochondriasis (fear of bodily ills), signs of genius in certain lines, the use of bywords, the formation of strong habits, mannerisms, speech defects and other noticeable qualities that brand the possessor as "queer" in not only the eyes of the examiner but also in the minds of associates who may have known the individual all his life.

It has been suggested that these ill-defined entities come in one generation, while in the next two or three, definite psychoses and mental deficiency appear and in the generations succeeding the

TYPES OF DEFECTIVES WHO ARE DEPORTED.

The case of the girl at the right will serve as a specimen of all. She is 17 years old, illiterate, and was able to pass hardly any of the tests of 12 years and under, which were given her in the primary and three secondary examinations. Her common knowledge was meager; she did not know the date, the number of months or their names; could name the days of the week forward but not backward; could count from one to 20 but not from 20 to one; and even in comparison with other illiterates from the same environment, she proved notably deficient. She was accordingly refused admission by the United States Public Health Service inspectors at Ellis Island. Photographs reproduced from the Survey (New York), January 17, 1914. (Figure 13.)

latter, organic diseases of the central nervous system occur, with possible extinction of the line unless a strong new blood is introduced. No comment need be made upon this but there must be some good reason why we are not all insane or deficient.

MARKED CHARACTERISTICS.

Before taking up the actual tests used in detecting mental enfeeblement some of the characteristics that are possessed in whole or part by all such cases may be enumerated. They are:

(1) Dullness and stupidity and an inability to make use of such knowledge as they may have acquired.

(2) Faulty reasoning and judgment and an inability to correctly estimate sizes, shapes and forms; difficulty in understanding any new system of life to which they may be subjected and customs and methods of procedure in the everyday routine, etc. They may find it difficult to take the measure of other people and therefore become the butt for practical jokes and the prey of confidence men.

(3) Lack of ingenuity and native ability. Defectives are usually only capable of performing work that they have already learned after painstaking training in much the same way that an animal is taught tricks. They are unable to meet emergencies and to act and think for themselves. They therefore follow others blindly into crime or slavery without thinking of their danger. Persons like these blindly follow the mob leader, dynamite boss, gangster or cadet.

(4) Faulty attention and memory. The first of these renders it practically impossible to learn anything complicated. The second makes it unsafe to depend upon such persons to perform necessary acts with which they may be entrusted, e.g., safety work for railroad companies.

(5) Exaggerated egotism, which gives them confidence in their own abilities, often at the expense of others. Defectives are frequently lewd, obscene and quarrelsome. Sexual atrocities and murder accompanied by torture and mutilation have been committed by them in the frenzies of temper and passion to which minor disappointments will sometimes drive them.

(6) Selfishness and absence of the altruistic sense are common attributes, although the feeble-minded are at times very faithful to those who care for and protect them.

(7) Emotional instability and hysterical outbursts are seen in various degrees. Illtimed mirth and grief and unusual reactions to minor excitations are common.

(8) Exaggerated suggestibility which causes them to be easily led and misdirected by more gifted persons.

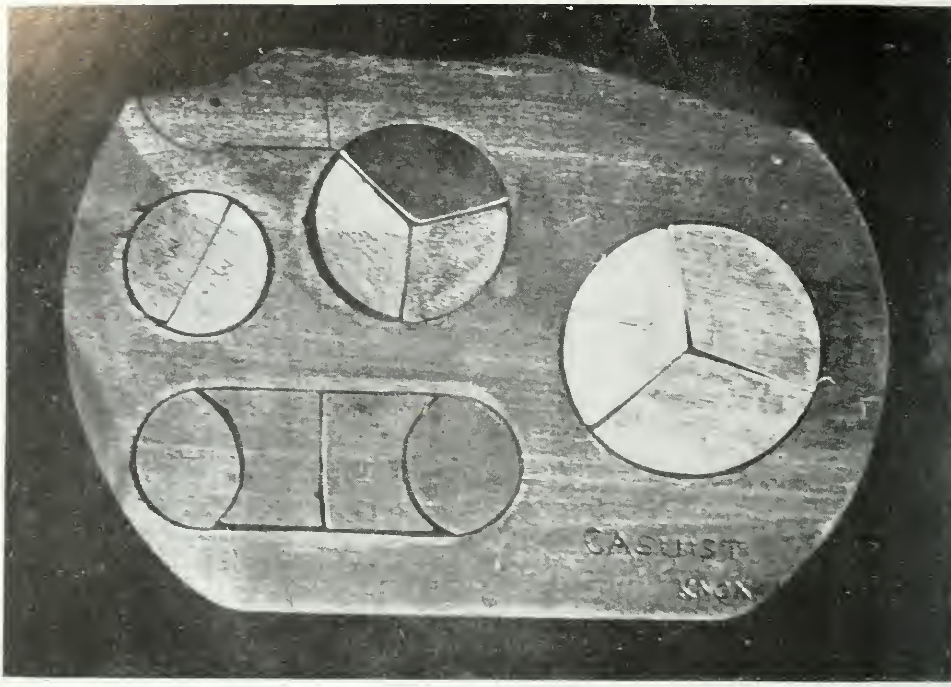
(9) Inability to withstand temptation. The baser qualities of the subconscious mind cannot be inhibited and dishonesty and other crime is the frequent result.

(10) Early brain fag and absence of the power of sustained energy. Such people are incapable of consistent efficient work for any great length of time. They are easily discontented and discouraged with each new position they obtain.

NOMENCLATURE VAGUE.

By this it is not meant that all defectives are possessed of all the above mentioned characteristics but it is true that every defective who is certified by the United States Public Health Service is possessed of a certain group of them and perhaps in some cases all of them. These ten are not all the peculiarities by which defectives in general are distinguished, but the elements and mental spheres enumerated here will serve to give a clear idea of what constitutes mental enfeeblement in the aliens who are presented for examination. Fortunately the term "feeble-mindedness" is regarded by most alienists as a sort of waste basket for many forms and degrees of weakmindedness, and since it is incorporated in the law as a mandatorially excludable defect, it is especially suited to the needs of the examiners who for the sake of conservatism and certain fairness include many imbeciles under the term.

The commoner characteristics of defectives have been given above. Know-



THE "CASUIST" TEST.

Properly to fit into their places the blocks of this frame requires the intelligence of a normal 12-year-old child. He should be able to do it in five minutes, or less, without making any mistakes that are not reasonable. At an older age, he should be able to do it in correspondingly less time. (Figure 14.)

ing the signs and manifestations, how may they best be elucidated and brought out in order to make a proper diagnosis and certificate? This is probably best accomplished by a graduated system of performance tests, accurately standardized, and a system of test questions of increasing complexity suited to the age, education and previous environment of the subject. The examining physicians are guided first of all by plain common sense, enthusiasm and personal feelings never entering into the consideration of any case. It is well for the sake of justice to the country and to the immigrant that this is so. The functions of the officers of the Public Health Service are purely advisory and not legal. Their duty is done when the proper certificate has been rendered; the people should not hold them responsible therefore if defectives are often admitted notwithstanding adverse certificates.

This is as important perhaps in the case of the insane as in the case of defectives and it is probably true that a great number of alien insane would not have become so had they not come to America. Such people are not fitted to become citizens of this country, although they may get along very well at home.

MANY INSANE CONCEALED.

It is probably true that the number of alien insane in the country is much larger than is generally supposed; in other words there are alien insane who never find their way to hospitals, their relatives knowing that if they do they are liable to be deported. Only the very dangerous and noisy insane reach the public institutions. The simple neuroses and milder forms of insanity remain at home in the care of their countrymen and friends, who, because of race pride or for other reasons do not wish the amount of insanity and disease they harbor to become known.

The dull, stupid immigrant is not so entirely because of his previous environment and opportunities. The environment and opportunities are the same now as they have been for countless centuries because of the immigrant's inability to change them. This country is as it is simply because it has been improved by men from prosperous northern European countries, which countries were prosperous simply because of the type of men who inhabited them. The civilization in Mexico is in its present state because of the nature of the people who settled there. It must be remembered that the form of government is the same there as in our own land and the natural resources are even greater. These factors are not to be blamed for the pitiable condition of the class of people that are coming to our shores at this time. They are simply undesirables and can never be assimilated to our advantage.

In a paper of this kind it is impossible to detail all the principles that underlie the deficiency tests used by the Public Health Service, nevertheless an outline can be given in such a way that one will understand the rationale of the examination and just what factors each test tends to bring forth.

In the higher and more refined grades of deficiency, the most important element in the diagnosis is the "human test" or the ability of one human being to take the mental measurement of another by conversing and associating with him. This intuitive ability can be very highly developed in persons of a strong and pleasing personality and good physique. It must be based on the experience of having seen and examined many positive and also normal cases and the examiner must be a broad-minded, big-souled man keenly alive to the frailties and shortcomings of the human race in general, including himself.

SOME DEFINITE SIGNS.

At the various ages in the lives of the simple minded there are definite signs that may be observed and which should aid one in forming a correct conclusion. Those seen in infancy are the ones least commonly known. They are seen in infants who are excitable or unusually quiet and apathetic. The eyes may roll about in an aimless stare. The child may be slow in learning to sit up, to walk or to use its hands. It may be slow to recognize objects and it may not respond to the caresses of its parents. It may be restless and irritable (exclusive of illness) and refuse to be pacified. It may sleep long and fitfully and there may be twitching of the face or limbs during sleep as well as bed wetting (in older children) and drooling both when asleep and awake. This drooling and failure to grasp the nipple properly are due to lack of muscular tone, protrusion of the lower jaw (prognathism), faulty reflexes, and too much blood (hyperaemia) in the salivary glands. These signs with clumsy use of the muscles are very frequently seen in infant defectives. The lower the grade of deficiency the greater the number and more marked are the signs presented. There may be in addition developmental digestive errors, vomiting without apparent cause, diarrhoea, poor hearing and delayed speech. It should be remembered that normal children are active, buoyant and playful while defectives may be possessed of a general inertia, sullenness and apathy that is altogether unnatural in that period of life. The child may be flighty and changeable, frequently indulging in silly laughter and chatter. The features lack individuality. The head may be malformed. The mouth may be coarse and expressionless and the teeth decayed and irregular. The breath and secretions may have a foul odor.

These are some of the obvious signs that would cause a child to be detained and submitted to a more detailed examination. Suffice it to say that the signs observed in older defectives are more numerous and perhaps more definite. It is true, however, that defectives are detected nearly every day who possess but few or no outward signs at all. This variety of inferior is detected solely by talking with him, and something is said to every immigrant who passes through Ellis Island or any other port of entry. At the primary line-inspec-

THE MOST DIFFICULT TEST.

The "feature-profile" test requires a degree of intelligence rarely found in the feeble-minded: a 12-year-old child or an adult with corresponding mentality may be expected to put it together in five minutes or less. The profile head is made of wood, half an inch thick, and its greatest measurements are six by ten inches. There are seven pieces exclusive of the main one, the eye, nose and mouth each comprising one, while the ear is made up of four sections which can only be fitted together in one way. Successfully to pass this test shows that the subject possesses ability to read a diagram; however, it is an entirely fair test, because the object is familiar to everyone. (Figure 15.)

tion questions are asked on the following subjects: the journey, experience during the trip, simple concrete addition and the ability to count backwards, facts of common knowledge that the immigrant should know and his grasp of his surroundings. This examination must be brief, rapid and to the point because from three to five thousand people must be questioned in this way each day. Those who do not answer satisfactorily are detained for a more detailed examination a few minutes later and if at this time their answers are more nearly correct they are allowed to go, otherwise they are detained for a third or even a fourth or fifth examination on other days and if at this time they are found to be defective they are so certified and deported, otherwise they are allowed to depart.

THE FINAL EXAMINATION.

The final examination will now be outlined in the order that its respective items are given to illiterate immigrants

over ten years old, it being modified for younger ones:

1. Select a quiet, well lighted and ventilated room, with a temperature of not over 68 degrees Fahrenheit. There must be no disturbing or distracting elements and the room must not have an official air, in fact it should look as much like a "den" in a private house as possible. Only those concerned in the examination should be present, that is, the interpreter and the examiners and in the case of children or timid people, a relative. The subject must have had good food and a bath previously and he must be mentally as tranquil as possible. The in erpreter should be kindly disposed towards the alien and understand him thoroughly and be understood by him. First question the subject about the ordinary occurrences and every-day duties of his previous environment. If he claims to have been a farmer ask about that vocation, if a tailor ask about that, framing the questions to the calling and previous style of living. Further than this ask about conditions as they exist in the town or locality from which the alien came.

2. Does he know the day of the week, the date, the month of the year, where he is, who he is, and who and what the examiner is? This set of questions determines his orientation and grasp on his surroundings.

3. Common knowledge comes next; the number of hours in a day, days in a week, weeks in a month, months in a year with their names, the difference between certain animals with which he is familiar, the names of flowers, musical instruments, etc., with which he is familiar, and brief descriptions of each.

4. Immigrants should be able to do simple addition although they have never attended school and all normal immigrants over eight years old can do it. After adding like numbers, they should be able to add unlike numbers, when one of the previously used like numbers is increased or decreased by 1, for instance, 4 and 4 =, 4 and 5 =, 4 and 3 =, 6 and 6 =, 6 and 5 =, 6 and 7 =, or 8 and 8 =, 8 and 7 = ; rapidly and without difficulty. They should be able to add the following numbers rapidly, realizing in each case that each succeeding problem is but 1 greater than was the previous one; 7 and 1 =, 7 and 2 =, 7 and 3 =, 7 and 4 =, 7 and 5 =, 7 and 6 =, 7 and 7 =, 7 and 8 =, etc. The vast majority of defectives excepting mathematical savants will go through a most laborious mental process in attempting to do this latter set of problems only to emerge with a most absurd answer, for instance, they may give the answer to 7 and 2 as more than the sum of 7 and 8.

MORAL TONE TESTED.

5. Ask questions which tend to show the moral tone as "Why is it wrong to kill?" and "How should one regard his parents as compared to other people?" and "Is it wrong to steal?" and if so, "Why?" Determine whether he would try to resist temptation, how he would meet evil suggestions and other questionable things. Some most astonishing answers have been obtained to these questions as in the case of a boy who, while he professed a love for his parents, wished them dead that he might inherit their property; he was 17 years old and was found defective by the other tests.

6. Construct as nearly as possible miniature problems and incidents of life as the alien has lived it in his country and ask what he would do in each position.

7. If he can count from 1 to 20, as all normal aliens usually can, he should be able to count from 20 to 1 without hesitation; he should have no difficulty in naming the days of the week backward.

8. He should be able to repeat six, or at least five, figures after the examiner, as 2-9-8-7-5-6-4, or 5-2-9-7-3. The figures should be given slowly and distinctly, not repeating each set more than twice.

9. The subject should be able to obey three or more simple commands as "open the door, bring me that book, and put this penny on the table."

10. After looking at a picture for thirty seconds, the picture containing 12 objects with which he is familiar, he should be able to name six of them from memory, without much hesitation.

11. A diamond or a square should be copied with a lead pencil even though he has never attempted this before.

12. The alien should be able to arrange in the order of their weights four cubes of the same size, weighing respectively 12, 15, 18, and 21 gms.

At this point comes the performing test examination. Just as Binet has evolved questions of increasing complexity for his French school children, so the United States Public Health Service has evolved a set of performance tests of increasing complexity. These are applicable to every age from three years upward and the point in the scale where an adult stops determines his mental age and the grade of defectives under which he will be classified. At the following ages the tests named under each should be performed within the time limit stated.

THE PERFORMANCE TESTS.[1]

At three years—

Should recognize toys and simple objects as such.

At four years—

Put some of the pieces in Sequin's formboard and do line "a" of the cube imitation test or touch any two of the blocks.

At five years—

Put all the pieces in Sequin's formboard in three minutes and do line "b" of the cube test or touch any three of its blocks.

At six years—

Do the "imbecile" test in five minutes with not over six false moves. Line "c" of the cube test is easy for normals at this age. The construction blocks may be started now; take three blocks all the same shape and build a figure with them, show this to the subject for twenty-five seconds, then break up the structure and ask him to build the same thing. (See Fig. 12.)

At seven years—

Do "G" or jigsaw test in three to five minutes, Sequin formboard in thirty seconds and "imbecile" test in less time and with fewer false moves than at six years. Add one block to construction blocks.

At eight years—

Do Healy frame test in five minutes and imitate line "d" of the cube test.

At nine years—

Do diamond frame test, in from five to ten minutes; Healy picture in less than four minutes, Seguin board in twenty seconds and complexity of construction blocks may be increased to work with five blocks.

At ten years—

Do "moron" test in less than ten minutes and all the details of the "visual comparison" test (see N. Y. Med. Jour., Sept. 13, '13) inside of ten minutes.

At eleven years—

Do the "e" line of the cube test without being shown more than five times. The eight, nine and ten year tests are performed in less time and with fewer mistakes.

At twelve years—

Do the "casuist" test in five minutes and any mistakes that are made must be "sensible" and not absurd. (Fig. 14.)

At thirteen to fifteen years—

Do "casuist" test in less time and with fewer mistakes than at 12 years; it should be done without first being shown made up or assembled. The "feature-profile" test should be correctly done in five minutes. The picture of a ship pasted to a board and cut into ten equal sized pieces of the same shape should be properly assembled in ten minutes. The pieces are all cut vertically. (Fig. 15.)

This concludes the performance tests after which a story is told the subject; the story contains five details and he is expected to remember three of them. A second story is told which contains an obvious absurdity; if the alien sees this absurdity it counts in his favor but if he does not, that fact does not count against him.

It is very evident that at the conclusion of this examination the physician is in a good position to give his subject a mental rating, provided of course that he tempers the tests with plenty of every day common sense.

[1] Dr. Knox is about to publish a more complete account of the special scale for the measurement of intelligence, classification of defectives, and performance tests, with report of cases, in the *Journal of the American Medical Association*. He will be glad to send interested members of the American Genetic Association the exact reference, or a reprint of the more extended discussion of the subject. The illustrations of performance tests published herewith illustrate the general character of all, but are, of course, only a few of the whole number used.—*The Editor*.

PLANTING PERSIMMONS

Japanese Variety Requires Pollinizers Under Most Conditions—Few Satisfactory Pollinizers yet found—Native Persimmon Can Not be Used, Because of its Incompatibility.

H. Harold Hume,
Glen Saint Mary, Florida.

EVER since *Diospyros Kaki* (commonly called the Japanese persimmon) was introduced and established in America about 1875, it has been noted in many sections that though the trees produce enough flowers to give good crops of fruit, the young fruits or ovaries of many varieties begin to drop shortly after the flowers open, and continue to drop, until, when the harvest season arrives, no fruit remains to be gathered, or so little that the planter is often disgusted with their behavior. In some seasons good crops are produced under conditions quite identical with those which prevailed in seasons when no crop was produced. The cause of this unfruitfulness and this sporadic fruitfulness remained very much of a mystery for many years. Naturally the cultivation of *D. Kaki* is not regarded favorably by many who have attempted it.

As is usual in such cases, many theories have been advanced to account for its non-fruiting. Some said that the trouble was due to too much cultivation, and that a system of weed or sod cultivation would correct it. Others said it was due to lack of potash in the fertilizer and that heavy applications of potash would correct the trouble. Still others said that the growth and development of the calyces forced the ovaries off, and so on. One theory after another was put to test, but regardless of theories and their application, the Japanese persimmon (*Diospyros Kaki*) has continued to act in the same manner—producing flowers abundantly, sometimes resulting in fruit, more often giving no harvest.

WHY FRUIT FAILS TO SET.

It was not until 1909 that attention was called to the true cause of barrenness[1] in *D. Kaki* and the year following, the cause of sporadic fruitfulness was learned. It was known years before to a few[2] that the flowers of *D. Kaki* are of two kinds, pistillate and staminate, but that this fact had any practical bearing on the problem of unfruitfulness did not seem to occur to anyone. More recently[3] the existence of perfect flowers, i.e., those containing both stamens and pistils, was brought to light. These flowers have no practical bearing on the problem, as they are rare and, from some cause or other not yet clearly understood, their ovaries very seldom develop into mature fruit. Since 1909, the results of more than twenty thousand hand pollinations have fairly demonstrated that pollination will cause fruit to set and grow to maturity, when without it, no fruit would be produced.

The fruitfulness of certain trees or groups of trees in some seasons and not in others even when pistillate flowers

[1]Hume, H. Harold. Non-fruiting of Japan Persimmons due to lack of Pollen. Science, N. S. Vol. XXX No. 76. Sept. 3. 308–309. 1909.

[2]Berckmans, P. J. Persimmons. Cyclopedia American Horticulture, 3. 1281. 1901; also Van Deman, H. E. The Kaki. Report of the Commissioner of Agriculture, 1887. 642–645. 1888.

[3]Hume, H. Harold. The flowers of Diospryos Kaki L. F. Trans. Acad. Science St. Louis Vol. XXII. No. 5. Dec. 31. 125–135. Pl. XXV–XXXI. 1913.

FRUITING BRANCH OF SIANG.

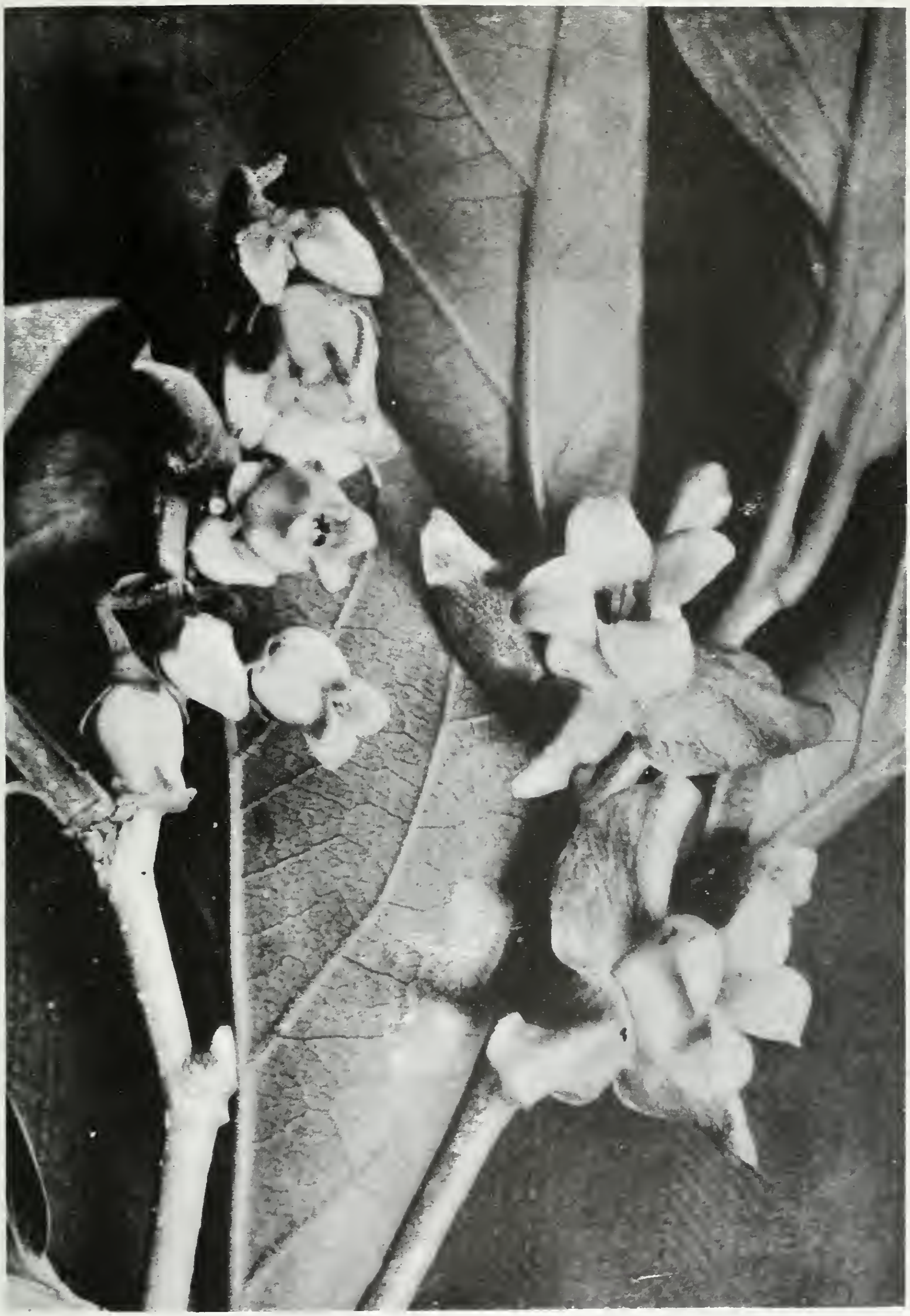
This variety (S. P. I. No. 21910) produces flowers of both sexes, and the persimmons here shown are from pistillate flowers pollinated from staminate blossoms on the same tree. So heavily fruited was the whole tree, that the fruit would have been much improved by thinning. (Figure 16.)

were present in goodly numbers each season can now be explained by the fact that there are certain horticultural varieties of *D. Kaki* which produce staminate flowers at irregular intervals. They may be found on certain trees one season and not the next. Many seasons may elapse before they appear again. It may even happen that never again are they produced, or they may be produced every other season. Many combinations of intervals or skips in the production of staminate flowers are possible and probable. A number of them have been observed and noted with reference to particular trees. The staminate flowers, when they occur on these trees, are abundantly supplied with pollen and fertilize not only the pistillate flowers on the same trees, but through the agency of insects the flowers of many trees surrounding them.

Careful examination of many hundreds of blossoms of the pistillate type showed that the stamens of these flowers are always abortive, and no pollen is produced in them. It was also learned that the flowers which contain pollen-bearing stamens are always different in structure from these pistillate flowers, so different indeed as to be readily distinguished from them.

THE SEARCH FOR POLLINIZERS.

Having then arrived at the large general cause of the unfruitfulness of *D. Kaki* and having determined that pollination would cause the trees to hold their fruit, our difficulty was to find dependable staminate flowering sorts. So far as any one in America knew, these did not exist, but it was believed that there were such trees. By accident one tree of unknown name and origin was found near Eagle Lake. Florida. It is dependable. One other



FLOWERS OF THE GAILEY TREE.

This Japanese Persimmon tree has been under observation since 1909, and each year has produced a very large percentage of staminate (male) flowers of the type shown at the right, wide open. The normal, pistillate (female) flowers are seen at the left, wide open. All trees propagated from this parent have likewise borne staminate flowers, and it may therefore be considered the most reliable pollen producer which has yet been developed in the United States. (Figure 17.)

from San Antonio, Texas, is promising and a third, a seedling at Glen Saint Mary, Florida, is known to have produced staminate flowers each season for three years. Through the efforts of David Fairchild, whose hearty interest and co-operation in the work has been of the greatest help, a number of other promising sorts have been secured from China and Japan. In a few seasons more, it will be known whether these sorts can be depended upon to produce staminate flowers abundantly every time they bloom.

Now, the question is not, "How does *Kaki* behave in Japan or China? And are pollinizers necessary there?" But the question is, "How does it act in the United States?" and to narrow it down still further, "Is it fruitful in Florida, or Georgia, or California?" Yes, and still more, "How does it behave in a certain county, on a certain farm, or in a certain dooryard?" And the answer must be that while in some localities pollinizers may not be necessary, under other conditions the planting of them is an absolute necessity, making, as it does, the difference between success and failure in securing crops of fruit; and in all cases the presence of pollinizers is an insurance against unfruitfulness.

BEHAVIOR VARIABLE.

It must be emphasized that the behavior of *D. Kaki* in its relation to pollination, or of any other fruit for the matter of that, in any one locality, is no index to its behavior under any other set of conditions. Even though the conditions may appear to be the same, there are differences which we are too dull to detect or too ignorant to understand, but which nevertheless operate on the trees and influence the results. It is a matter of observation that under certain local seasonal and climatic conditions some varieties of *D. Kaki* will set good crops of fruit without pollination (seedless of course) while under another set of conditions they do not do so. One season they may bloom freely and set all the fruit the trees should carry and with an equal amount of bloom in another season the same trees may bring no fruit to maturity. To sum up the conditions as they are at present in the Lower South, and based on numerous observations extending over more than a decade, it is a fact that trees of all varieties of *D. Kaki*, in good health and which bloom under normal weather conditions, can be depended upon to bear good crops if pollinated, and it is equally true (a few varieties only excepted) that they will not do so if pollen is not provided. In the last two seasons it has been amply demonstrated that all that is necessary is to have staminate flowering trees in proximity to the pistillate ones and bees, wasps, flies and other insects will take care of the problem according to nature's own plan.

POLLINATION NOT A CURE ALL.

It must not be concluded, however, from these remarks that pollen bearing trees in a Japanese persimmon orchard are a cure for each and every case of unfruitfulness. There are other factors which enter into the problem of barrenness. The trees may not bear fruit because they are unhealthy—they may be poorly nourished or they may be suffering from attacks of insects, (the flat headed borer, *Dicera obscura*, in particular) or fungi or bacteria. Again the trees may not even bloom, and the forces which make for flower production, intimately bound up as they are with environmental pressure on the activities of the protoplasm, are not well understood. But if the trees are in good condition, not starved on the one hand, and not forced into too vigorous and succulent growth on the other, they can usually be depended upon to bloom. Even though the trees may bloom profusely and both staminate and pistillate flowers are present in the orchard, the activity of insects, upon which pollination depends, may be greatly restricted or completely suppressed by untoward weather conditions. High winds and heavy rains combined make a condition particularly unfavorable for successful and satisfactory pollination, both because the flowers or their essential parts may be injured and because the insect pollen carriers cannot work.

Neither must it be expected that

FRUIT OF TAMOPAN VARIETY, ACTUAL SIZE.

This is one of the most valuable varieties in China, where it is practically seedless. It is propagated on a large scale by native horticulturists and sold more commonly than any other in some of the most important markets. In the United States it seems never to produce any staminate flowers, but, on the other hand, it seems not to require pollination for successful fruiting. It has not been widely enough tested to determine its behavior with certainty. (Figure 18.)

every pistillate flower on *D. Kaki* trees will set fruit even though there is an abundance of pollen nearby. Pistillate flowers are produced singly in the leaf axils near the base of the twigs of the current season's growth. There may be anywhere from two or three to eight or ten flowers in the lower nodes of a new shoot, and if every one of these flowers produced fruit, the trees would be very much overloaded. Fortunately this does not occur, however, and trees which are heavily fruited do not set more than one fruit for every six or eight flowers on an average. In very much overloaded trees, the number sometimes runs as high as one in three or four. This percentage is too great in some cases and it would be better to remove a considerable portion of the fruit to increase the size and quality of that which is allowed to remain. The percentage of flowers which produce fruit under proper conditions is higher than

on other fruit trees, where the flowers are borne in clusters, as is the case with apples, pears and plums.

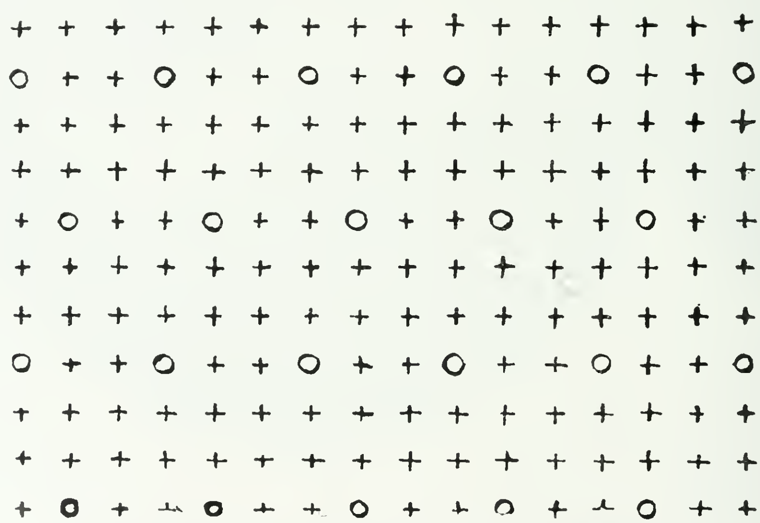
NO HELP FROM D. VIRGINIANA.

In a very large part of the area in which *D. Kaki* may be grown, the common American persimmon, *D. Virginiana*, is native and very naturally the question may be asked, will not staminate trees of this species serve as pollinizers? This the writer thought possible a few year ago. The evidence at hand so far proves that they are entirely worthless for this purpose and the proximity of staminate *D. Virginiana* trees has no influence whatever on the fruitfulness of *D. Kaki*. Moreover out of many hundred hand pollinations between *D. Kaki* and *D. Virginiana* using both species as the male parent no viable seed has so far been secured. They appear to be absolutely incompatible. It may be pointed out in passing that evidence is accumulating which shows that the presence of staminate *D. Virginiana* trees is essential to the fruitfulness of pistillate trees of the same species in some localities. The necessity of pollinizers for *D. Virginiana* has been denied by some writers.

It follows therefore that to make fruitfulness certain it is a wise plan in all localities to include *D. Kaki* pollinizers in the planting, and with most horticultural varieties of *D. Kaki*, in most sections, it is a provision of fundamental necessity. What varieties can be used as pollinizers?

Quite a number of varieties of *D. Kaki* are known to produce staminate flowers. The list now known in this country comprises Okame, Taber's No. 23, Taber's No. 129, Gailey, Masugata, Siang (S. P. I. No. 21910) New Sien (S. P. I. No. 22368) and S. P. I. No. 27037. All of these have produced staminate in addition to the pistillate flowers, and occasionally perfect flowers (i.e., those containing both stamens and pistils) have been found.

Thus far the most painstaking and careful examination of many hundreds of trees, when in bloom, has failed to reveal the presence of staminate flowers on varieties Costata, Hachiya, Hyakume, Tsuru, Tamopan, Tanenashi, Zengi, Triumph, Yemon, Yeddoichi and



PLANTING PLAN FOR JAPANESE PERSIMMONS.

In order that there may be pollinizers wherever wanted, but not elsewhere, Mr. Hume recommends setting them in the positions indicated by small circles in the above diagram, the crosses indicating ordinary female trees. (Figure 19.)

Phelps. Under some conditions some of these same varieties may produce them.

CONFUSION IN NAMES.

It must be remembered, too, that there is much confusion in the names of varieties of *D. Kaki* dating back to the time of their introduction into America. The older varieties mentioned have been under observation for many years and are believed to be correctly named. Particular reference must be made to Tanenashi, a normally seedless variety which fruits well without pollination. It is very difficult to secure seed in its fruits from the most careful hand pollinations. It would be a drawback to have pollinizers near this variety if the pollen from them caused seed development. Fortunately pollination has practically no effect on it in this particular. The ovules have so far proved to be largely sterile. There is some evidence to prove that Tamopan is very similar to Tanenashi in its behavior toward pollination.

Unfortunately very few of the varieties which have produced staminate flowers can be depended upon as pollinizers. Okame, Taber's No. 23 and Taber's No. 129, for instance, produce staminate flowers one year and not the next, though pistillate flowers are borne each season. Of these three Taber's No. 129 is the most constant in its behavior. Gailey (as the tree found near Eagle Lake has been named) is known to be a *constantly staminate* variety, i.e., it produces a good percentage of staminate flowers every time it blooms. The other varieties mentioned cannot be placed at this time as they have not been under observation long enough. The lists will doubtless be largely increased within the next few years as the behavior of new introductions becomes known. Seedlings are also being raised and doubtless they will add to the number.

Hence the only variety which can be recommended at this time, as a pollinizer, is Gailey. This variety has a long flowering season, and the flowers are abundantly supplied with pollen. The fruit, however, is quite small, and consequently not so valuable as the larger sorts with which it would be planted.

PLANTING PLANS.

For this reason, and for another reason which will be touched upon later, the number of Gailey pollinizers in the orchard should be reduced to a minimum, having in mind at the same time that enough trees should be set to produce the pollen necessary to insure good crops of fruit. While it is a recognized fact that pollinizers are necessary in plantings of other kinds of fruits such as apples and pears, for instance, it is also a fact that specific recommendations as to the number of pollinizers required and their location in orchards of these kinds have seldom been made by writers on this subject.

The full complement of seeds (eight) is objectionable in fruit of *D. Kaki*, particularly in the smaller varieties. If one seed develops in a fruit, its development appears to be quite as efficient in causing fruit to hold as if the full number is formed. It has been observed, moreover, that as the distance of a tree from the pollinizers increases, the average number of seeds in the fruit decreases. Therefore to reduce the number of seeds in the fruit to a miminum, the number of pollinizers should be reduced to the very least number which will provide for effective fruit setting. This problem has not yet been worked out absolutely and additional time will be required to decide it definitely.

Plantings made this winter have been made according to the accompanying diagram. It will be noted that the pollinizers are placed every third tree in every third row, in such a way that the spaces in the pollination rows are broken. The proportion is one to seven or eight. In large plantings by this plan, each tree requiring pollination has a pollinizer, directly adjoining it on one side. It may be that a lesser number will in the end prove satisfactory, but there is no doubt but that this plan will insure sufficient pollination for even the most pronounced sterile varieties such as Hachiya and Yemon.

TOP-WORKING.

What is the owner of an orchard already planted to do if he desires to place pollinizers in his orchard? It is quite easy to bud over branches here and there in properly placed trees. No preliminary cutting back is necessary as the buds may be inserted where the bark is anywhere from one to three years old. The work should be done just as the leaves are coming out in spring, using the ordinary method of shield budding and tying the buds in place with waxed cloth. The wraps should be left on about three weeks and as soon as the buds have taken, the branches should be cut back, leaving stubs five or six inches long to which the shoots from the buds may be tied as they grow out. These stubs should be removed at the end of one season's growth.

ITALIANS TAKE UP EUGENICS

On November 17th, the Roman Society of Anthropology organized an "Italian Committee" for the study of eugenics. The Directors are:

Prof. Giuseppe Sergi, *President.*
Prof. Sante de Sanctis, *Vice-President.*
Dr. Cesare Artom, *Counsellor.*
Prof. Corrado Gini, *Counsellor.*
Prof. Mangiagali, *Counsellor.*
Prof. Alfredo Niceforo, *Counsellor.*
Dr. F. Umberto Saffiotti, *Secretary.*

INTERNATIONAL EUGENICS CONGRESS

The Organizing Committee of the Second International Eugenics Congress met in New York City, January 2,1914 and elected Professor Alexander Graham Bell Honorary President and Professor Henry Fairfield Osborn, President. The nucleus of a General Committee was also named. Professor Osborn has accepted the Presidency. It is probable that the Congress will hold its meetings in the latter half of September, 1915, at the American Museum of Natural History, New York City.

A. B. A. PUBLICATIONS WANTED

On the inside back cover of this issue will be found a list of the American Breeders Association annual reports, and back numbers of the American Breeders' Magazine, which the association still has for sale. There is a constant demand for the other numbers and reports, particularly from libraries which wish to complete files. Those who have any copies of the annual reports, or of the magazine, other than are enumerated on the inside back cover, will confer a favor by notifying the secretary, if they are willing to sell them.

The

Journal of Heredity

(Formerly the American Breeders' Magazine)

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CONTENTS

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Date of issue of this number, March 26, 1914.

THE SMALL ARABI CLASS OF KARAKUL.

These ewes are the only two good ones secured by Dr. C. C. Young in his first importation of sheep from Turkestan. They are full-bloods of the Small Arabi class, which he considers one of the best for breeding purposes. The lambs beside them, from Teddy senior furnish skins worth as much as $12 each for fur. This photograph was taken by Dr. Davidson at the quarantine station, Athenia, New Jersey, while the importation was being held to detect the possible presence of surra or some of the other Asiatic sheep diseases which are justifiably feared, and the fear of which leads to the almost total prohibition of the importation of sheep from Asia. (Frontispiece.)

See "Breeding Karakul Sheep," page 170.

DIFFERENTIAL FECUNDITY

How Various Races of the United States Are Altering Their Relative Positions—Native Americans Dying Out in New England—Whites Supplanting Negroes in the South—Influence of Cities on the Birth-Rate.[1]

WALTER F. WILLCOX,
Professor of Economics and Statistics, Cornell University, Ithaca, N. Y.

HAVING been honored with an invitation to address you upon the subject of "differential fecundity as one of the causes of the need for race betterment," I have felt it both a privilege and a duty to accept the invitation.

At the start it is well to define *fecundity*. This is the more necessary because the definition used in biology and medicine differs somewhat from that used in statistics. The definition propounded by Professor Raymond Pearl in his paper before the First International Eugenics Congress at London in 1912 was as follows: "the innate potential reproductive capacity of the individual organism as denoted by its ability to form and separate from the body mature germ cells." For human statistics this definition is inapplicable and useless. Statistics disregards potential as distinguished from actual or realized fecundity and makes fecundity a characteristic, not of men or women, husbands or wives, but of marriages. For present purposes, then, it is a term applied to marriages which have proved fruitful in the birth of at least one child, and is thus the opposite of sterility.

In some technical discussions a distinction is drawn between fecundity and fertility, the former being applied indiscriminately to every marriage which has resulted in the birth of a child, the latter taking into account also the number of children born to the marriage. If we were to accept this distinction, two marriages, to one of which a single child had been born, and to the other of which six children had been born, would be equally fecund, for fecundity has no degrees, but the marriage which had resulted in six children would be more fertile than the other. In the present paper, which must be general in character, the distinction between fecundity and fertility will be ignored. For our purposes, fecundity means the yield of living births in any population group in a unit of time, usually a year. This yield can seldom be effectively stated as a total number of births, for such a number ignores variations in the size of the group which produces it. To avoid this difficulty fecundity is stated ordinarily as a proportion or ratio, called the *birth rate*.

WHAT DIFFERENTIAL MEANS.

The word *differential* also must detain us a moment. The differences which it implies are differences in the fecundity of various population groups and, in consequence, differences in the rates at which these groups perpetuate themselves and multiply by nature's processes of birth and death. The real things to be compared are the rates of increase or of decrease resulting from the balance between these natural processes. The birth rate or fecundity gives only one term when what is wanted is the difference between two terms, the birth rate and the death rate. A population group may increase either by excess of births over deaths, by excess of immigration over emigration, or by various combinations of these two kinds of change reinforcing or antagonizing each other. An increase by excess of

[1]Address delivered before the First National Conference for Race Betterment. Battle Creek, Mich., January 10, 1914.

births, or what is called natural increase, differs from an increase by excess of immigration over emigration, or migratory increase, in that it is more likely to carry on into the next generation through heredity the main characteristics of the parent stock. Where the group is increased by immigration there is less warrant for supposing that its qualities will be perpetuated.

My real theme, then, may be phrased as "Differences in the Rates of Natural Increase," a more accurate title than "Differential Fecundity." In addition to defining my subject more exactly, this has an incidental advantage. The fecundity or birth rate of the population of the United States is unknown; the fecundity of any of the numerous groups into which that population may be divided, with the possible exception of a few states, is likewise unknown. Neither do we know the mortality or death rate of the population of the United States, although we do know the death rate of many states and are rapidly advancing towards a determination of the rate for the entire country. These facts might seem to make a paper on "Differential Fecundity" or "Natural Increase" almost impossible. But if a group is unaffected by migration, its total increase at one date over the number at a prior date, determined from two successive censuses, is a measure of its natural increase. The population of the United States is far from satisfying this condition, yet within it there are certain groups, e. g., Negroes and Indians, so little affected by migration that we may measure their natural increase from census returns, though neither their fecundity nor their mortality is known. Even for the whites the effort to measure the natural increase by allowing for the increase due to immigration is not absolutely fruitless.

SCOPE OF THE PAPER.

My subject, then, assumes that the population can be divided into groups, the natural increase of which can be determined and compared, and my aim is to review the present state of statistical knowledge regarding the natural increase of such groups. The American population groups of whose natural increase I shall speak briefly are the white and the Negro races, the native and the foreign born, the several nativity strains among the foreign born, the urban and the rural population.

Among savage or semi-civilized people, the overwhelming majority of whom live little above the starvation point, there is a reciprocal relation between births and deaths. When the deaths increase, the births decrease; when the deaths decrease, the births increase. For example, in European Russia in the famine year, 1892, the deaths exceeded the annual average of the years before and after the famine by more than half a million, and the births in that year fell below the annual average for the years before and after by more than 300,000. Conversely, in such countries a bountiful crop lowers the death rate during the time the food lasts, and raises sharply the birth rate a few months later. Most civilized countries have emancipated themselves from this close dependence upon food and in them no relation can be traced between the crop of grain and the crop of babies. In such countries the only surviving relics of this reciprocal relation between births and deaths are found in cases of war and pestilence. Thus, in Massachusetts, the effect of the Civil War was apparently more marked in reducing the birth rate than in raising the death rate. The first of the recent epidemics of influenza, sweeping rapidly from Russia over Europe and her outposts in the winter of 1889-90, was the main reason that in nearly every civilized country 1890 was a year with a very high death rate. But no attention has been called to the fact that the births in Europe during that year were 200,000 below the average of the preceding five years, and that these losses of life by reduction of the births came in each country from eight to ten months after the mortality from the epidemic reached its height.

DECLINE IN BIRTH RATE.

During the last fifty years or less the most marked change in the birth rates and death rates of civilized coun-

tries has been the gradual decline and almost complete disappearance of this reciprocal relation between births and deaths, whereby the most significant changes were those between one year and the next and these changes were usually in opposite directions, and the appearance in its place of a tendency for birth rates and death rates to decrease slowly but steadily for a long series of consecutive years. The annual variations are much less, but the total change in ten or twenty years much greater than under the earlier conditions. Usually the decline began with the death rate and in that case its effect would necessarily be to magnify the natural increase. But a decline in the birth rate soon began and is proceeding now in most civilized countries about as fast as the death rate. Indeed, such a change was inevitable, if the natural increase was not to be more rapid than the increase in wealth or food. We must never forget that the decline in the birth rate and that alone has enabled mankind to hold fast the advantages promised by the advance of civilization and the sharp fall in the death rate. The serious and disturbing fact is not the mere decline in the birth rate, but the differential decline. Apparently many strains or lines of descent which one might most desire to see continued and increased are strains which are losing ground relatively, if not absolutely, by a decrease of the birth rate more rapid than that of the death rate.

The largest and in some respects the most important population groups about whose rates of natural increase I wish to speak this morning are the great races of man, the European, Asiatic, and African. Their increase has been and still is in the main dependent upon differences in the certainty and sufficiency of the food supply. The great reason for the rapid multiplication of the European folk and their descendants in other parts of the world from perhaps 130 millions in the middle of the eighteenth century, to more than 550 millions now, while during the same period the numbers of other races have altered but little, is found in the fact that new territorial discoveries and new methods of stimulating agricultural production and the transportation of persons and goods have concurred to increase enormously the supplies of food available for the white race. There is no reason to suppose that the fecundity or fertility of this race is greater than that of other races or greater than it formerly was; its natural increase has been unprecedented not because its birth rate has risen but because its death rate has fallen, and fallen more rapidly than its birth rate.

HOW THE NEGRO LOSES GROUND.

In our own country and especially in the southern states this divergence in rates of natural increase is working out results of interest for the two great races. That the white race is slowly displacing the Negroes in the United States is now well known. That this is due to differences in the rates of total increase is equally familiar. But the whites are being constantly reinforced by immigrants and the Negroes are not. Where migration is a potent factor, total increase is an untrustworthy clue to natural increase. For this reason we may get nearer the truth by confining attention to the southern states. Under the slavery régime and the saturnalia of reconstruction which followed, i. e., from 1790 to 1880, the increase of the two races in the South, and, so far as we may disregard the effects of migration and identify natural increase with total increase, their natural increase was at about the same rate. During this ninety years, when the Negroes were fewest relatively they were 35% of the total population of the South; when they were most numerous they were 38%, a difference of only 3%. But since 1880 the southern whites have increased much more rapidly than the southern Negroes and as a result the proportion of the latter is dwindling. In 30 years that proportion has decreased more than 6%, or more than 2% in each decade.

In the United States as a whole the more rapid increase of the whites is due not only to the influx of hundreds of thousands of white immigrants, but also

to the fact that in the registration area in 1910—an area including nearly three-fifths of the whites and more than one-fifth of the Negroes, and so a fair index of conditions in the country at large—the Negro death rate exceeded the white by about two-thirds. If the fecundity of the darker race likewise exceeded that of the whites by two-thirds, the difference in the death rates would not entail a different rate of natural increase. Although no exact measure of fecundity can be gained until there is an effective registration of births, a rough substitute for it has been found in the proportion of living children under five years of age to 1,000 women of child-bearing age.

NEGRO FECUNDITY.

Measured in this way, the fecundity of the American Negro is and has been for the 60 years since 1850 greater than that of the white. During the 30 years since 1880—and those are just the years within which the proportion of Negroes in the South has been falling—the excess in the proportion of Negro children over white children in the country has likewise been falling. The present difference in fecundity between the races is little more than one-fourth of that in 1880, and at present rates of change it will have disappeared entirely before the next census is taken. In the South the proportions of children in the total population and in each race are notably above the corresponding proportions in the North. Indeed it is probable that a main reason for the greater fecundity of the Negro race is found in the fact that this race, of which nearly nine-tenths live in the South, has the high fecundity characteristic of the South, and the white race, of which the majority live in the North, has the lower fecundity characteristic of the North. For in the southern states the proportion of children to women among whites already exceeds that among Negroes by 10%.

The evidence, then, points to a differential natural increase as an important factor, a factor in my opinion at least as important as immigration, in determining the present and future relative proportions of the two main races in this country.

Among the whites, the main classes whose differential fecundity has been somewhat studied, are the native and the foreign-born stock. This branch of the inquiry is difficult not only because of that lack of data which almost baffles one in studying the differential fecundity of white and Negro, but also because the lines between the two classes are fluid and variable. A son born of immigrant parents the day after their landing is of the same stock as they, yet in the statistical tables he stands as a native American and they as foreign-born or immigrant. Although efforts have been made to measure the proportion of the white population of the United States at the end of the nineteenth century which sprang from the whites who were in this country at its beginning, and the proportion due to immigration during the century, yet none of the results seems to have won or to be entitled to general acceptance, and for that reason I must pass this topic as still a happy hunting ground for conjecture.

CHANGES IN MASSACHUSETTS.

A careful and illuminating study of the comparative fecundity of the native and foreign-born population of Massachusetts and of the various strains of the foreign-born in that state during the 15 years, 1883-1897, was made in 1901 by Dr. R. R. Kuczynski.[2] The proportion of married women who had outlived the child-bearing age without having borne any child was 9% among the foreign-born, and 15% among the native, indicating that the proportion of sterile marriages is about two-thirds greater among natives than among foreign-born. The average annual number of births among 1,000 immigrants was more than three times as great as among 1,000 natives of the United States. But a large proportion of the natives and a small proportion of immigrants are children, and for this reason a fairer comparison of fecundity was secured by excluding the children both

[2]In the *Quarterly Journal of Economics* for November, 1901, and February, 1902.

from the native and from the foreign-born. After this correction has been made, the fecundity of the foreign-born was found to be a little more than twice that of the native. The birth rate varied with the place of birth of the mother, the lowest rate being found when the Massachusetts wife was born in some other New England state; the highest rate when the Massachusetts wife was born in Portugal, the latter rate being more than four times the former. When all women over 50 years of age and all younger unmarried women were excluded, the birth rate of foreign-born wives was found to be greater than that of the native by about three-fourths.

Another study of the fecundity of married women in New Hampshire, comparing native and foreign-born wives, and introducing a classification by age, added the interesting result that, while the birth rate of foreign-born wives at all ages was twice that of native wives, this was a resultant or average of differences which grew steadily greater with the age of the classes compared. The birth rate of foreign-born wives at ages under 20 exceeded that of native wives by less than one-fourth, but at ages 25 to 34 it was more than double and at ages 35 to 44 was almost treble that of native wives.[3] This suggests that a large part at least of the difference between the fecundity of the native and the immigrant stock in New Hampshire is due to psychological rather than physiological causes, or causes which express themselves in the voluntary choice of small families rather than in sterility. An attempt to estimate the comparative fecundity in 1900 of native and foreign-born women in the United States, including wives and spinsters and with no allowance for differences in age distribution, indicated that the fecundity of foreign-born women exceeded that of native women by more than 50%.[4]

The statistics of Massachusetts, although they were probably as good as those of any state, did not and do not yet afford the information needed for a thorough study of the death rates, and so of the difference between birth rate and death rate, or natural increase, of the native and foreign-born, but a comparison of the existing material with that furnished in Berlin, where a similar problem has been studied perhaps as carefully as anywhere in the world, led Dr. Kuczynski to conclude that the native population of Massachusetts is probably dying out at a rapid rate.

NATIVE POPULATION DYING OUT.

Since his articles were written, material has accumulated making it possible to compare the mortality of the native and the foreign-born in 1900 in the registration area of the United States, which embraced two-fifths of the population of the country and much more than that proportion of the foreign-born, and in 1910 in New York State.[5] These results show that for ages between 10 and 40 there is very little difference between the death rates of natives and of foreign-born of the same sex and age, and that what differences do exist are quite as often in favor of the foreign-born as the native. Since the fecundity of the foreign-born is at least 50% greater than that of the native, and the mortality is about the same, the difference between them, or the natural increase of the foreign-born, must be far above that of the native population.

Another classification of the population has been employed in studies of differential fecundity, that into the urban and the rural population. Under urban is included all residents of cities each having at least 25,000 inhabitants, all the rest of the population being treated as rural. The division line of 25,000 is much too high, but the form

[3]A. A. Young, "Birth Rate in New Hampshire," in American Statistical Assn. *Quart. Pubs.*, IX: 280 (September, 1905).

[4]Twelfth Census, *Supplementary Analysis*, p. 420.

[5]This is the only fact brought out, I believe, for the first time in the present paper. The results for New York State in 1910 will be found in my last report as consulting statistician to the New York State Department of Health; the confirmatory results for about forty per cent. of the population of the United States in 1900 have been computed from a ms. table kindly furnished me by the Census Bureau.

of the printed tables makes it impossible to put the limit lower. The fecundity of city women between 15 and 44 years of age is only about two-thirds that of country women. But in the United States cities are massed at the North, and the North has a low fecundity. The low urban fecundity, then, may be due to the northern location and not to city life. To test this, a comparison has been made between the cities of the North and the country districts of the North, and between the cities of the South and the country districts of the South. Such a comparison indicates that in all main divisions of the United States fecundity in country districts is greater than fecundity in cities It indicates also that the difference between city and country in this respect is at a minimum of about 10% in the North Atlantic group and at a maximum in the southern groups where rural fecundity is about double urban fecundity. This geographic difference may be plausibly explained as due to the numerous immigrants in Northern cities and their high fecundity, and to the numerous Negroes in Southern cities and their low fecundity. For the fecundity of city Negroes is only about two-thirds the fecundity of city whites, but the fecundity of country Negroes is much above that of country whites. The growth of cities, especially in the South, and of a Negro urban population seems likely to increase the differences in the fecundity of the two races.

FECUNDITY OF IMMIGRANTS.

The twenty-eighth volume of the Report of the Immigration Commission, printed in 1911, contains a contribution to our subject entitled, "Fecundity of Immigrant Women," the main conclusions of which have been summarized by its author in an article in the last issue of the *Quarterly Publications* of the American Statistical Association.[6] The tables were compiled from manuscript data in the United States Census Bureau and deal in the main with nearly 80,000 married women under 45 years of age living in the second decade of married life and with the number of children they have had.

This is the most important American study of fecundity, and supplements in many ways what we previously knew. It classifies white wives as native of native parents, native of foreign parents, and foreign-born, and adds scanty data about Negro wives. Of the Negro wives who had been married between 10 and 20 years, one in five had had no child; of the native white of native parents, one in eight; of the native white of foreign parents, one in 16; and of the foreign-born wives, one in 19. The proportion of sterile marriages was determined for the various nationality classes of the foreign-born; it is highest among wives born in Scotland or England; lowest among wives born in Poland, Bohemia or Russia; and the proportion of sterile marriages among those where the wife was born in one of the first mentioned countries is about four times as great as among marriages where the wife was born in a country belonging to the second group. Among no group of foreign-born wives, however, is the proportion of sterile marriages as great as among marriages where the wives were born in the United States.

With reference to the average number of children born to these groups of wives of various countries of birth, the smallest number is to wives of native American birth and parentage. Ten such marriages have resulted in 27 children; 10 Negro marriages in 31 children; 10 marriages in which the wives were born in England, in 34 children; and at the other extreme, 10 marriages with wives born in Russia, in 54 children; 10 with wives born in French Canada, in 56; and 10 with wives born in Poland, in 62.

The average interval of time elapsing between births is for wives born in the United States, 5.3 years; for wives born in Poland, 2.3 years. This interval between births is uniformly greater in the second generation of immigrants than in the first. But the proportion of sterile marriages does not rise simi-

[6]Joseph A. Hill, "Comparative Fecundity of Women of Native and Foreign Parentage," in Am. Stat. Assn. *Quart. Pubs.*, XIII: 583-604.

larly. So the tendency is to a reduction in the size of families rather than to a larger proportion of sterile unions.

FEWER BIRTHS IN THE CITY.

The influence of rural conditions upon fecundity is best measured by the statement that among wives born in this country of native parents and married between 10 and 20 years, 10 living in urban districts have had on the average 24 or 25 children, while 10 living in rural districts have had on the average 34 children, indicating that the fecundity of wives of a given nativity class living in the country is about two-fifths greater than it is in the city.

Perhaps the most important body of information regarding differential fecundity or comparative rates of natural increase in the United States has been secured as an immediate or remote result of the addition to the Massachusetts census schedule of 1875 of the question, "Number of children borne by women," the object of which "was to ascertain the relative fecundity of women of different nationalities and to settle . . . the question which continually arises concerning the growth of our native population as compared with that of our foreign born."[7] Ten years later similar information was sought in fuller detail by asking of each married woman two questions: "Mother of how many children" and "Number of those children now living." The results of tabulating the answers to these questions were carefully analyzed in the state census and were also of importance to Dr. Kuczynski in the preparation of his articles. The interest aroused in these questions and their answers was so great that five years later, in 1890, the same questions were placed on the schedules of the United States census, but unfortunately no tabulation of the results was ever made. In 1900, after much consideration by the office, the same questions were asked again, and again, after much preliminary work had been done upon the answers, the work was discontinued and no results ever reached the public except for the fragmentary tabulation made by the Immigration Commission and applying to about 4% of the population.

VALUABLE DATA NEGLECTED.

Yet again at the census in 1910 these questions were repeated a third time and in the Report of the Director of the Census to the Secretary of Commerce and Labor for that year one may read the following passage: "It is also proposed . . . to work out from the returns on the schedules statistics with regard to fecundity as indicated by the number of children born and the number living for women of different classes in comparison with their age and the duration of marriage. . . . A considerable amount of preliminary work on this subject was undertaken at the census of 1900 but the results were never tabulated or published. It is respectfully suggested that the Secretary recommend to Congress that the Director of the Census be authorized to tabulate the more important information on this subject for the 1900 census as well as that for 1910. . . . This subject is one of profound importance and the census schedules furnish data by which conclusions of the utmost value can be readily drawn. A plan has been devised by which the expense of . . . tabulating the results on this subject for the census of 1910 will be much less than would have been necessary to complete the work on the lines begun in 1900."[8]

At the present time no funds are available for completing this work and there is danger that for the third time the inquiry will suffer shipwreck. This investigation has been imitated abroad, some of the most interesting and significant results of the last French census and also of the last British census being derived from the answers to similar questions. In my opinion the failure to utilize the answers to these questions was one of the main defects of the census of 1890, was the most serious defect of the census of 1900 and now bids fair to be the most serious

[7]Mass. Census of 1875, Vol. 1, p. xli.

[8]Report of the Director for 1909-10, pp. 45-6.

defect of the census of 1910. In Dr. Hill's paper already quoted, and written a few weeks ago, we read: "It is to be hoped . . . that the returns obtained at the census of 1910 will not be similarly neglected, but as yet no steps have been taken towards their tabulation." If it had been the policy of this conference to adopt resolutions or make recommendations, I should have proposed the adoption of some such resolution as the following:

Resolved, that the National Conference on Race Betterment appoint a committee with power

1. To memorialize the Congress of the United States in the name of this Conference, urging it to provide the funds needed for compiling the returns now on the schedules of the census of 1910 and thereby measuring the fecundity of the races and national elements within the United States:

2. To attempt to secure the presentation of similar petitions from other organizations or from individuals interested in this subject.

Whether such a resolution would be welcome or not, I sincerely hope that individuals will write to individual congressmen urging such action as is here proposed.

In my judgment, no statistical result could come from this conference more valuable than a concerted effort to increase the available information regarding the comparative fecundity of the various strains in our population, for this information lying unused in the government files is of more value and importance than the entire sum of knowledge on differential fecundity now possessed by the American people.

The Need of Accuracy

Legislation with regard to the sources of racial degeneracy is certain to become more and more frequent in the near future; the idea of race betterment is not the monoply of a few faddists and cranks; it is growing to have an almost religious significance with a large number of persons in this country [England] and the movement foreshadowed by the present Mental Deficiency Act, is certain to grow apace whether or no it be backed by a scientific study of degeneracy. Shall there or shall there not be an accurate science of eugenics on which we can base legislative action? Shall we be content with mere expressions of opinion, with slipshod data, and with inaccurate treatment of even such material? The only answer possible is that we cannot be satisfied with such a condition of affairs in the case of man. The service of man demands the very best that science can produce, and those of us who have the highest hopes for the new science of eugenics in the future are not a little alarmed by many of the recent contributions to the subject which threaten to place eugenics with the older "social science" and much of modern sociology—entirely outside the plane of true science. Eugenics ought to be an accurate description at worst, a quantitative and exact appreciation at best, of the biological forces which control the evolution of national welfare.—David Heron: Mendelism and the Problem of Mental Defect (1913).

Eugenic Civilization

The best form of civilization in respect to the improvement of the race, would be one in which society was not costly; where incomes were derived chiefly from professional sources, and not much through inheritance; where every lad had a chance of showing his abilities, and, if highly gifted, was enabled to achieve a first-class education and entrance into professional life, by the liberal help of the exhibitions and scholarships which he had gained in his early youth; where marriage was held in as high honor as in ancient Jewish times; where the pride of race was encouraged (of course I do not refer to the nonsensical sentiment of the present day that goes under that name); where the weak would find a refuge and a welcome in celibate monasteries and sisterhoods, and lasty, where the better sort of emigrants and refuges from other lands were invited and welcomed, and their descendants naturalized.—Francis Galton: Hereditary Genius (1869).

ALASKA'S REINDEER INDUSTRY

Peninsula Could Provide Grazing for Millions of Animals, in Region Where Cattle and Sheep Will Not Thrive—Meat Excellent and Brings High Price—Herd of 40,000 Now Exists, as Result of Importations by Government.

LEVI CHUBBUCK,

Agriculturist, Office of Farm Management, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

IN 1851, sixteen years before Alaska was purchased from Russia by the United States, Professor S. F. Baird, in a paper printed in the Agricultural Report of the United States Patent Office, advocated the importation of the domesticated European reindeer to Alaska for the benefit of the natives, whose means of subsistence by hunting and fishing, were being greatly diminished by the white men. Professor Baird expressed the opinion that the American caribou, native in Alaska, was as capable of domestication as the European species, but to avoid loss of time and save the people from the vicissitudes that were rapidly sweeping them off, he suggested the establishment of herds of the imported animals. Such a step, he said, would be of vast benefit to the Indians of the North, and might in the end lead them to become a pastoral people.

Twenty years after the purchase, which was in 1867, Charles H. Townsend took up the matter and advised that the government import reindeer, teach the natives how to care for and use the animals, and give them a start with herds.

Forty years after Professor Baird suggested the idea, the first move was made to act on the suggestion, when, in 1891, the late Dr. Sheldon Jackson, general agent in Alaska of the Bureau of Education, took hold of the proposition. Aided by donations from private sources, he purchased a small herd of European reindeer which arrived in Alaska in 1892. Successive importations brought the total to 1,280 head, which number has increased to about 40,000 at the present time.

W. T. Grenfell, the well-known missionary in Labrador, has succeeded in getting reindeer from Lapland introduced in Labrador and northern Newfoundland, and W J. Carroll, of Newfoundland, says: "It is to be hoped that the introduction of reindeer will be the first step towards the domestication of our own caribou."

THE REINDEER'S WILD RELATIVES.

David E. Lantz, in Bulletin No. 36, ot the Biological Survey, U. S. Department of Agriculture, speaks of several species and local races of caribou or reindeer that inhabit the northern part of North America, which he divides into two groups according to habitat. The more northern group, which ranges beyond the forests, is represented by the barren-ground caribou (*Rangifer arcticus*). The second group is found in the forested area south of the other, and is represented by the woodland caribou (*Rangifer caribou*). They differ but little, Mr Lantz says, from the old-world reindeer (*Rangifer tarandus*) in habits and general appearance, although no attempts to domesticate the American reindeer seem to have been made.

While, so far as the writer knows, no systematic effort has been made to test the matter, it is alleged that there have been instances of cross breeding between the domesticated reindeer and the native animals. This would not naturally take place except when both species were in captivity; but if such cross-breeding is a fact, it indicates that the blood of the wild caribou might be used to good advantage, should there be need of building up the reindeer herds. There is evidently already need of work along

AN OLD MALE SIBERIAN REINDEER.

The reindeer is the only member of the deer family that has been domesticated, and shares with the dog the honor of being the only domesticated animal of the far North. Its genus (*Rangifer*) is the only one of the deer family in which the females, as well as the males, regularly possess antlers. Under ordinary conditions it lives to the age of 10 or 12 years, and furnishes food, clothing and labor to its native owners. It can draw 250 to 300 lbs. on a sled and travel all day at the rate of 10 miles an hour: its pace is an awkward, straddling walk, rarely a gallop. (Figure 1.)

this line in some districts where it appears that from lack of care in the selection of breeding animals, the domesticated deer are decreasing in size and developing other signs of degeneracy. The native caribou are superior in size and vigor to the imported animals. There seems to be no evidence as to whether they can actually be domesticated, but there should be no difficulty in employing them to infuse new blood into the herd of tame deer, should that seem desirable.

MUCH LAND AVAILABLE.

Here would seem to be an opportunity for some broadly conceived scientific and practical government work of large economic possibilities: A region sparsely occupied by a worthy and needy race,

AN OLD MALE WOODLAND CARIBOU.

An adult buck weighs from 350 to 400 lbs., and at the beginning of autumn carries a thick layer of fat on the back and rump, which furnishes a highly prized article of food to natives. Sir John Richardson says: "The flesh is tender and its flavor, when in season, is in my opinion superior to that of the finest English venison; but when the animal is lean, it is insipid, the difference between lean and well-fed caribou being greater than one can conceive, who has not had an opportunity of judging." Zoologists now divide the caribou, distinguishing a dozen species in North America; the one shown here is the Newfoundland Caribou (*Rangifer terranovae*). Photograph made at the New York Zoological Park. (Figure 2.)

the Eskimo, whose means of living have become very much restricted in recent years, and who make excellent reindeer herdsmen; the nucleus of an animal industry in the 40,000 reindeer now owned largely by the Eskimo; and a region practically unoccupied, with perhaps 100,000 square miles of pasturage suitable for the reindeer; at any rate sufficient to sustain herds reaching into the millions in number. In the April, 1903, number of The National Geographic Magazine, the editor, in an article on "Reindeer in Alaska," said: "In thirty-five years the number may reach 10,000,000 head."

It may be worth while to note in this connection, that in the two northern countries of Sweden, Norrbotten and Vesterbotten, comprising 63,000 square miles, the Lapps own 230,000 reindeer. Large herds are also owned in the north of Norway and in Finland.

The western half of Alaska, including

all the territory north of the Yukon River, is the region best suited to the reindeer, and it is also the section in which other agricultural opportunities are the most meagre and conditions for home making least favorable. A development of the reindeer industry can therefore be had without encroaching on districts where other lines of farming are more feasible. The white reindeer moss (*Cladonia rangiferina*) is found in all the arctic region of Alaska, on the Seward Peninsula and the tundras of the western portion of the territory, and in the mountains of the Alaska range and of the Alaska peninsula. Its existence not only permits the occupancy of vast regions that would otherwise be practically uninhabitable, but makes possible the production of a food supply of large economic importance.

LITTLE CARE REQUIRED.

The existence of great herds of native caribou that have grazed, and are yet found in considerable numbers in regions north of the Yukon River, and in various other parts of the peninsula as well, indicates clearly the kind of animal husbandry feasible in that part of Alaska. By building on nature's foundation, a great domestic animal industry may be established in regions where the climate does not favor the introduction of cattle and sheep. The reindeer subsist on the native herbage, principally the reindeer moss, winter and summer, require no shelter and little care beyond being restrained by a herder from wandering. The reindeer meat is of excellent quality, and the skins are valuable. Little attempt has thus been made to use the deer for dairy[1] or transportation purposes, as is done in Europe.

The larger proportion of the reindeer now in Alaska are within 200 miles of Nome, and nearly one-half of all are on the Seward Peninsula. From that district the herds are scattered as far north as Point Barrow on the Arctic Ocean, south to points on the Alaska Peninsula, and eastward up the Yukon River to Tanana, which is about midway between the Canadian boundary and the west coast.

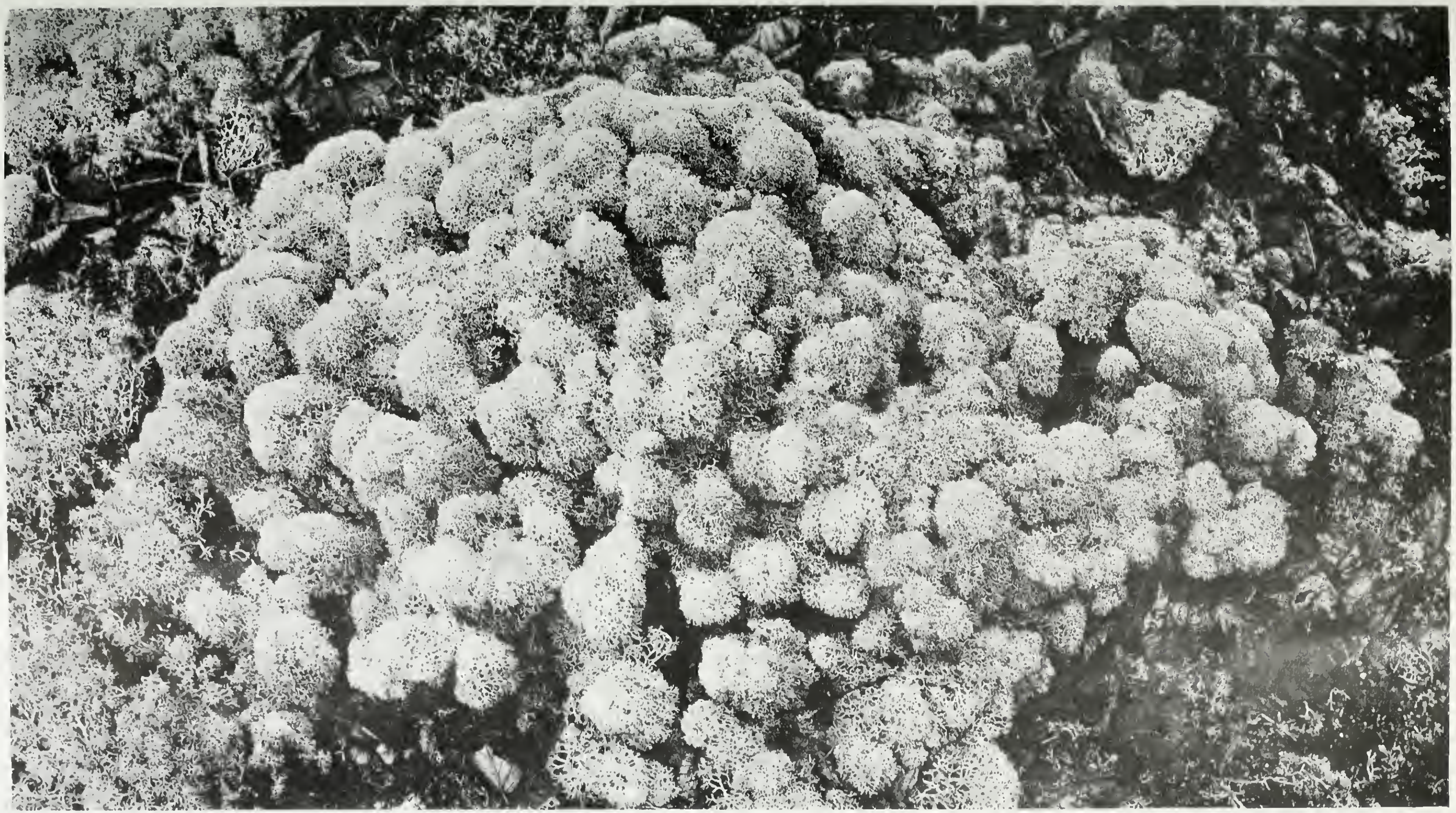
At present the individual ownership of reindeer is restricted to Eskimos and Indians, with the exception of a few Lapps who were brought in with the original importations as caretakers, instructors and herders. Some of the missions are still in possession of herds, and there are a few government herds. No breeding deer are allowed to be sold to whites. The Alaska Division of the U. S. Bureau of Education, Department of the Interior, has supervision of all the herds, the teachers of the government school for native children located nearest a herd having immediate charge. In 1911 one hundred carcasses of deer were shipped to Seattle from Nome, and the meat sold at 75 cents a pound.[2]

INCREASE NOW SLOW.

Thomas A. Powers, of Unalakleet, Alaska (near St. Michael), in a letter to the writer dated August 16, 1912, says the increase in number of reindeer is only one-half that of cattle, due, he thinks, to the unscientific management introduced by the Lapps and followed by the natives, and to permitting the latter to dispose of young deer. He expresses the opinion that the government should, if possible, appraise the deer held by the Lapps and missions, buy them and distribute to the natives, and then put the industry in charge of a capable American cattleman, with a corps of able assistants, who would handle it on a scientific basis. "The reindeer industry is, as you know, in its infancy," he concludes, "and, not-

[1]The reindeer is milked by the Lapps once or twice a day, furnishing only a cupful at a time, and this "comes hard." The milk is so thick that it must be diluted for drinking; it is correspondingly rich, but has a strong flavor and odor, somewhat like the milk of goats. Butter from it tastes like tallow, and is little used, but much cheese is made. The does are fresh in the spring, when they produce their fawns, one or two in number. In Alaska the animal is rarely milked.

[2]Up to the present, local markets in Alaska have been able to use all the reindeer meat available, butchers buying the animals dressed at about 25 cents a pound. Reindeer may profitably be killed at the age of seven or eight, when they have outlived their greatest usefulness for transportation purposes. They are broken at the age of two. The average Alaskan carcass weighs about 130 pounds, dressed.



REINDEER MOSS IN MINNESOTA.

Strictly speaking it is not a moss at all, but a lichen (*Cladonia alpestris* in this photograph; *C. rangiferina* is quite similar). Sometimes it forms masses a foot thick. The reindeer usually eats nothing else during the winter, while the native, when he kills an animal, takes the half-digested moss from the stomach and eats it as a relish and anti-scorbutic. Photograph furnished by Professor Bruce Fink, Miami University. (Figure 3.)

withstanding its early mismanagement, gives promise of a mighty industry, and should be carefully fostered so that in years to come the states could rely upon an ever-increasing supply of reindeer meat. To do this, means should be used to stop waste and decrease casualties, and this will never be so long as the Lapps and missions hold so large a number of deer, and the natives, who do not look to the future, are permitted to handle the deer as they will."

Japhet Linderberg, president of the Pioneer Mining Company, Nome, Alaska, a recognized authority on reindeer, says the tundra fires, in destroying large areas of moss, are a great menace to the reindeer industry. These fires are very extensive all through the interior, where the light precipitation and the peaty character of much of the area permit them to smoulder and burn until not only all the vegetation, but much of the soil is destroyed.

NEW PUBLICATIONS

REPORT OF THE COMMITTEE TO STUDY AND TO REPORT ON THE BEST PRACTICAL MEANS OF CUTTING OFF THE DEFECTIVE GERM-PLASM IN THE AMERICAN POPULATION, by Harry H. Laughlin, Secretary of the Committee. Vol. I, The Scope of the Committee's Work, Vol. II, The Legal, Legislative and Administrative Aspects of Sterilization. Eugenics Record Office Bulletins Nos. 10A and 10B, Cold Spring Harbor, Long Island, February 1914. Vol. I, 64 pp., 20 cents; Vol. II, 150 pp., 60 cents.

"The investigation reported in this series of studies was initiated at the second meeting of the Research Committees of the Eugenics Section of the American Breeders' Association at Palmer, Mass., May 2 and 3, 1911." Following the reorganization of the American Breeders' Association, the committee continued its work independently under the chairmanship of Bleecker Van Wagenen. The other members are now W. H. Carmalt, Everett Flood, H. W. Mitchell and H. H. Laughlin, and they are assisted by a staff of 20 expert advisers on different phases of the problem, which they have undertaken to study from every point of view. The two bulletins under consideration are preliminary in nature; "in the subsequent reports of this committee," it states, "we propose by the means of first-hand facts, a considerable body of which has already been secured and studied, to present to the public data for weighing the several problems which appertain to this investigation."

According to the first volume of the series, the committee proposes that the lowest tenth of the population of the United States be "cut off" during the next two generations, by an extension of institutional care, i. e., "life-long segregation," complemented by sterilization wherever necessary. The second volume takes up the latter part of the problem, and analyzes in an exhaustive way its present status. All laws which have been passed with the object of dealing with this aspect of cacogenics are quoted in full; opinions of experts are given as to their constitutionality; in cases where they have been attacked before the courts, extended accounts of the cases are given; and finally, the committee submits a "model law" of its own.

It is interesting to note that in spite of the great amount of discussion of this supposed cacogenic remedy, which has been carried on during recent years, and the laws passed in 12 states to apply it, the committee estimates that less than 1,000 legal operations have been performed under these laws to date. It is declared, indeed, that more operations "have been performed without the sanction of the law than have been performed under its provisions, or even under its shadow." As is well known, California is the only state where the law is at present being enforced, the other 11 states having formally or informally abandoned the project, either in response to public sentiment, or because of adverse decisions of the courts.

THE EXISTENCE OF SPECIES

Organization through Interwoven Lines of Descent a Characteristic of Species—Biology Not Advanced by Ignoring this Fundamental Condition—Eugenics a Problem of Maintaining the Species, rather than of Separating Varieties.

O. F. Cook,

Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

THAT all the plants and animals are organized into species is a fundamental fact of biology. If the organization of species were confined to a few groups of plants or animals it would have been considered very remarkable and would have been made the subject of special investigation. But being universal and altogether familiar, the existence of species is taken entirely for granted in some branches of biology and as completely disregarded in others.

Darwin had deeper insight into the problems of evolution and heredity than many of his successors, because he saw that these problems relate to species; that is, to species in the sense of natural groups of interbreeding organisms. Taxonomic complications regarding species have been allowed to confuse the issues to such an extent that current writers on general biological problems leave the phenomenon of specific organization entirely out of account or even deny that species have any real existence. A single instance may serve to illustrate this tendency:

> "We have devised a scheme whereby we regard animals as segregated into a series of groups—species, genera and so on—subordinated one to another. We arbitrarily separate these groups by sharp lines. While the scheme expresses, to some extent, our ideas concerning the past history of animals, the groups themselves have no real existence 'in nature,' as we say. There these sharp lines do not exist. The species or other group has no definite limits in space, no form, no integrity. It has no organization as a whole."

Plants and animals can be investigated in many ways without taking account of the organization of species. The interwoven lines of descent that bind the members of a species into a coherent organization may be separated, as in the breeding of varieties of our domesticated plants and animals, and endless experiments can be made with such varieties without considering their derivation from an ancestral specific organization. Many investigators prefer to study varieties rather than species because varieties have more uniform characters and more definite differences, so that the results of experiments are more readily reported in statistical form. When this preference is taken into account it is not surprising that theories of heredity should have been based upon facts drawn from the study of varieties, without considering the organization of the species.

THE SPECIES IN EUGENICS.

As long as our interest is limited to the varieties that are brought into the garden or the breeding pen for experimental purposes, it may appear better policy to avoid reference to species, but in the study of eugenics this policy can hardly be maintained, for eugenics does not have the same purpose of developing specialized uniform varieties. The problem of eugenics is to learn how to improve the human species in other ways, without destroying individual diversity or the normal network of descent. Human progress, to be permanent and secure, must be made in normal evolutionary ways, instead of by any direct imitation of the method of producing our short-lived varieties of domesticated plants and animals. Hence

a recognition of the existence of species and an understanding of the organization of specific groups would seem to be necessary steps in the development of a science of eugenics. To overlook the specific organization of living matter is to leave out of account the fundamental and unique condition of organic existence and of evolutionary progress.

The obvious purpose of the study of evolution and heredity is to understand how the complex and highly specialized bodies of plants and animals have been built up, and how they are rebuilt in each generation. From an evolutionary viewpoint, it is apparent that the cellular organizations represented in the bodies of plants and animals have developed through the association and differentiation of cells, and that progress in cellular evolution is dependent upon the organization into groups of interbreeding individuals, the groups that are usually called species.

Among the lowest forms of life the individual organisms are merely single cells, and the cells are all of one kind, and all of these cells taken together constitute the species. Organization, in the sense of building up cellular structures, begins when the cells associate in colonies, instead of living as separate unicellular individuals. After the habit of living in colonies has become established, the species is thought of as made up of colony individuals, rather than of cell individuals. In other words, the specific organizations of single-celled organisms furnished the materials for making colonies and building higher types of cellular structures.

PROGRESS THROUGH DIVERSIFICATION.

The next stage of organization is reached when the members of a colony of cells are not all of the same kind, but become specialized in form and function. The building up of the higher types of cellular organization involves the association of vast numbers of cells. The specific organization and the cellular organization have made mutual progress. Special systems of reproduction have been developed, making it possible to build up these highly complex forms of organization. It has not been sufficient to have different kinds of cells to make up individual organisms. Diversification has been raised, as it were, to the second power, in that different kinds of polycellular individuals are represented in the specific organizations. Sexual and other forms or diversity among the members of species have developed in all of the higher groups, to accompany increasing specializations of cellular organization.[1]

The dependence of the cellular organization upon the specific organization continues and becomes more apparent as we ascend in the scale of the structural complexity, and is shown by the need of crossing of lines of descent through sexual reproduction. The species and the individual are morphological facts, and sexuality the physiological function that connects them. The species is a network of interwoven lines of descent and has as real an existence in nature as an individual animal or plant. The species produces the individual and the individual adds its share to the network of descent of the species. To think of the individual as producing itself without reference to the specific organization is like assuming the spontaneous generation of a complex cellular structure.

The true nature of a species as represented by a network of descent is not apparent if we consider only the few individuals that may be taken to represent the species at a particular moment of time. In order to see the network we must visualize the past and the future, in accordance with the facts of organic succession. Narrowing our view of a species to a short period of time is like focusing our attention on the cross-section of a fabric. This enables us to examine the free ends of the individual threads, or to study an occasional knot, but we lose sight of the network as a whole.

THE SPECIES UNDERLIES ALL.

There is no structural organization without underlying specific organiza-

[1]Cook, O. F., and Swingle, W. T. Evolution of Cellular Structures, Bulletin 81, Bureau of Plant Industry, U. S. Department of Agriculture, 1905.

tion. Organisms maintain their existence and make evolutionary progress only in species. It is the species, rather than the individual, that has a truly biological existence. Evolution and heredity are collective, superorganic processes, hardly to be understood from the standpoint of the individual organism. Instead of disregarding species, students of general biological problems should consider the association of all plants and animals in species, in other words, the speciety of living matter, as one of the most significant and fundamental facts. That this condition or property of speciety is not analogous to any of the physical and chemical properties of unorganized matter, should give it a special interest for the biological investigator.[2]

The traditional analogy of the genealogical tree also gives a misleading idea of the nature of organic succession. The usual object of a genealogical tree is to show descent from a single ancestor, and unless consanguineous marriages occur, all the branching lines of descent remain separate and distinct. But this apparent distinctness is maintained only because each marriage is a grafting with a branch of a different family tree. If all these genealogical trees with their intergrafted branches could be represented, we would have a diagram corresponding to the network of descent of the species.

That the network of descent is lacking in definite form or external morphological structure is not a reason for denying that the species has organization, for amoebae and many other living organisms lack definite form. This is true even of some highly specialized organs, such as the brain, whose functions are not at all dependent upon regularity of external form. Morphological specialization is, after all, only a secondary result of protoplasmic specialization. The conditions that determine protoplasmic efficiency must be recognized before we can hope to understand organization in the external, structural sense.

Some have thought to gain a better understanding of heredity by analyzing the diversified natural species into uniform pure lines, where the analogies of the physical sciences more nearly apply. Yet evolution is not an analytic process, but highly synthetic. The specific organization of interweaving lines of descent provides for the accumulation and combination of the desirable variations, those that render the species better adapted to its environment. To unravel the network of descent into separate lines may help us to understand some of the problems of heredity, but it does not represent the essential condition of normal, self-perpetuating organic existence, or of evolutionary progress. None of the analytic experiments in the propagation of single lines of descent are permanently successful. If the crossing of the lines of descent is prevented, as by vegetative propagation or by artificial breeding, the individual structures become abnormal or weak and eventually cease altogether. Our vegetative varieties and pure bred strains are short-lived. None of the higher types of plant or animal life are maintained without sexual reproduction in a specific network of descent.

THE NETWORK OF DESCENT.

To say that the power of organization is lodged in the individual germ cell is not the whole biological truth. The power resides rather in the specific organization, the protoplasmic network of the species, of which the individual germ is but a fragment. The vitality of the individual depends upon its relation to the organization of the species. The specific networks of descent, rather than the individual lines, have the power to develop and maintain the complex structures of the higher animals and plants. Organization in this sense of complex cellular structures is not a general property of protoplasm, for it is not manifested by the lowest forms of life, but is rather to be considered as an accomplishment of the higher forms, those that have developed complex specific organizations and correspondingly specialized sexual

[2]Cook, O. F. Physical Analogies of Biological Processes. The American Naturalist, 46: 493, 1912.

processes for maintaining the networks of descent of the species.

Why the interweaving of lines of descent in specific groups is necessary to maintain the power of cellular organization we do not know, but neither do we know why the overlapping of metal plates generates the electric current in a voltaic pile. The facts are established by repeated observation, and should not be disregarded in our attempts to understand related phenomena. Of course, these complexities of specific organization and sexuality are very unwelcome ideas to those who are about to solve the problems of evolution and heredity by simple experimental and statistical methods, but no truly biological investigation can disregard the fundamental fact that organisms exist in species.

That categories of classification of species are artificial is not an indication that the groups themselves have no real existence. As well might we say that continents and islands have no real existence because their shore-lines are not definitely fixed and do not coincide with parallels of latitude and longitude which geographers use to determine locations. The object of biological classification is to find our way about in the endless diversities of organic nature, and for this purpose many conventional devices are employed but these should not be allowed to conceal the more essential facts.

FINDING THE LIMITS OF SPECIES.

Students of classification are always seeking diagnostic differences between the various species and higher groups, for the task of discovering such characters and framing them into words is very difficult. Hence taxonomy makes only gradual progress, like other departments of science. Yet the formal nature of the concepts and categories of classification does not affect the concrete nature of the groups that are being classified. The categories of the biologist are artificial like those of the geographer, but not more so. Geographers do not agree in the grouping of the archipelagoes of the Pacific Ocean, but this is not considered a reason for denying that islands exist or that some islands are close together and others far apart. Species are biological islands, in a sea of non-existence. The higher categories of classification, such as genera, families and orders, are more conceptual than species, in that they do not form coherent networks of lines of descent, but even this deficiency does not render them pure abstractions. They are to be considered rather as collective entities, that is, they are groups of species that stand in certain phylogenetic relations to each other, corresponding to the positional relations that determine geographic groups.

It is true that the boundaries of species often appear less definite in nature than in books, but the same is true of islands where the shore lines change with every tide, to say nothing of the more extensive and permanent changes by erosion of cliffs or elevation of beaches. Yet these incidental limitations need not destroy concrete ideas of islands as continuous bodies of land, nor of species as coherent groups of organisms. The members of each species are bound together by a network of lines interbreeding into a physiological unity, quite independent of morphological similarities or diversities inside the species. It is organization that constitutes the species, not the characters that may be ascribed to it.

The difficulties of classifying and discovering diagnostic characters for the several millions of species that exist on the earth's surface should not be allowed to confuse the minds of physiological and statistical workers, or to obscure the reality of specific organization. The specific structure or speciety of living matter is as truly a fact as any other biological phenomenon. That there should be so many species, and so difficult to classify, adds annoying complexities to biological investigation, but the difficulties are not removed by disregarding the existence of species. Sailors encounter similar difficulties in the navigation of archipelagoes, but do not find it safe to overlook any of the islands that lie in their courses.

COLLECTING IN TURKESTAN

Work of Botanical Explorer Hindered By Many Difficulties and Even Dangers—Wild Vegetation Scarce and Flora Not Rich—Native Fruits of Mediocre Quality But Extremely Hardy and Resistant to Drought and Alkali.[1]

Frank N. Meyer,

Agricultural Explorer, Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

Tashkent, Turkestan.

Aug. 20, 1910.

ALL this delay is, as you surely will feel with me, of very great annoyance and becomes really depressing. There are moments when the loneliness of this exploration work becomes too great and I would like to fly off to regions where I could find more intellectual and social surroundings. And I have such a long journey yet ahead of me. Great Scott! before I appear somewhere in Eastern China, I'll have gone through many a lonesome day! That's one of the troubles connected with exploration in out-of-the-way places; this loneliness and this great waste of valuable time and energy. Of course it could be worse yet. Polar expeditions are still way ahead of our work in waste of all sorts of things.

As I wrote you from Samarkand on July 4, 1910, I had engaged a guide and had had an interpreter already for a few days. We had seen the police about our trip and the chief had said everything was O. K., but in Pendshikent we would have to get a paper from the police there.

On Tuesday, July 5, we had negotiations with various horsemen and cart-people and as we were assured that in Pendshikent we would be able to get cheaper and better horses, we went by a large cart to that last named city on the next day, where we arrived after a hard ride at ten o'clock in the evening of that same day.

A PLAGUE OF LOCUSTS.

On Thursday, July 7, we inspected the grain market and seed stores, where I bought some samples of various things and in the afternoon we had conferences with the police and with horse men. I got a paper from the acting chief of police and on Friday, July 8, we left Pendshikent. We travelled first through a dry, elevated plain, where scanty growth of wheat, barley, linseed and rape was to be seen, while tens of thousands of locusts were devouring whatever they could find. In the afternoon we went through some gullies and passes and then mountain climbing had begun. On a few places we saw some beautiful Eremurus and yellow larkspurs, but in general the mountains were devoid of vegetation, save some Astragalus and a *Capparis spinosa* and some Artemisias. At 9 P. M. we stopped at last in a town called Stood, about 5,000 feet above sea level. We slept on the porch of the Muhammadan temple and got but little

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[1]The story of Mr. Meyer's entry to Turkestan was told in the March issue of The Journal of Heredity; the continuation of it, as told in letters to his chief, is given herewith. The accompanying photographs are all by Mr. Meyer: the scientific names are in the form used by him, and not necessarily in the form adopted by the department, when the material was distributed to plant breeders in the United States. Mr. Meyer's exploration of Turkestan resulted, as most plant breeders know, in the introduction to the United States of many tons of material, including hundreds of species of plants suited to desert climates, which are being tested in the southwestern United States. His collection of alfalfas was perhaps the most valuable single contribution. Mr. Meyer is now engaged in a three-year exploration of eastern China, where he has already made important discoveries of chestnuts, jujubes and persimmons.—The Editor.

THE VALUABLE KARAGATCH TREE.

This dense-headed, desert shade tree (*Ulmus campestris umbraculifera*) is found throughout Russian and Chinese Turkestan, although the forms in the two countries are distinct, according to Meyer. The photograph shows a particularly beautiful specimen at Orono, in the province of Samarkand, Russian Turkestan, July 13, 1910. It has been introduced to the United States, and promises to be extremely valuable in the arid Southwest. (Figure 4.)

supper that night, it being too late to find anything.

On Saturday, July 9, I went around for several hours in the mountains, collecting seeds and herbarium material and at noon we left with our little caravan of six horses and six men (interpreter, guide, three horsemen and myself). We passed through a wild, mountain valley, where a roaring torrent was still eating out its bed deeper and deeper; after having scaled a dangerous, dry mountain, we arrived at sunset at a beautiful but cold lake at 10,000 feet altitude; this lake is called Kalikulan and is fed from the eternal snows on the mountains around. The water was so cold that one wouldn't readily bathe in it, and as for drinking, one could only take a mouthful at the time. The soil in these high regions is sterile and the growing season very short, for the snow melts away in early May and returns again at the beginning of September. Still one finds there masses of Junipers (*Juniperus foetidissima*), Barberries, bush honeysuckles (*Lonicera sp.*), yellow roses (*Rosa xanthina*), a mountain ash (*Sorbus thianshanica*), besides various herbaceous plants like *Eremurus sp.*, *Gentiana verna*, Leonurus (?), several Compositae, etc. We were lucky enough to find at the lake an encampment of a local Sart administrator and slept that night in a tent made of carpets, but still it was cold, after coming in two days from the hot plains.

SCARCITY OF FOOD.

On Sunday, July 10, we left our lovely, silent sheet of water and climbed over one high and difficult mountain, where

NATIVE PLUM IN FULL BLOOM.

Russian Asia is rich in native plums, some of which are valuable commercially, while others are promising only as hardy stocks for grafting. *Prunus insititia*, shown in this picture, is locally known as the alutcha, and is said to be extraordinarily prolific, as well as a regular bearer. Some of the species are quite ornamental. Meyer mentions one found along a watercourse in the mountains near Kulikalan, Samarkand, Turkestan, at an elevation of 6,000 feet, which had light green leaves and bore long racemes of small, oval, scarlet fruits of a bitter-sweet taste. It and many other species are now growing in the United States, as a result of his exploration. (Figure 5.)

the descent was at times even dangerous and, horses and men all being tired, we camped at 4 P. M. on a grassy, level place, near a stream, and had a great time in getting enough to eat, for there are very few people in this elevated region of Central Asia and food is scarce and at times altogether unobtainable. We got, however, sour milk and pea-flour bread and, with some conserved sausages which we had still with us, we made a meal of it. The interpreter could not stand the rarefied mountain air; he had heavy hemorrhages from the nose twice a day and felt quite weak. The guide, who was addicted to strong drink, could not get anything, of course, and had become very sullen, so you may imagine that I was not in a sociable company.

Well, on Monday, July 11, we passed through wild, rocky scenery, going along precipices where the horses had to be held by two men, one at the head and one at the tail, so as to prevent accidents. In the afternoon, about five o'clock, while collecting wild cherries on the mountain slope, we came all of a sudden upon a caravan, consisting of 20 people and still more horses. It proved to be the civil-administrator of the district, accompanied by the chief of police of Pendshikent, an interpreter, local chiefs of villages, guards, scouts, etc.

Our meeting was somewhat remarkable, as few white men ever travel in these regions.

The first thing we were asked for was, of course, our passports. The administrator (a Russian police-officer of high rank) said that my papers were not as they ought to be, as they were not defi-

SPIRAEA HYPERICIFOLIA.

One of the most ornamental wild shrubs of Asiatic Russia, found from the Caucasus region and Persia eastward to Mongolia and the region of Lake Baikal. It is able to stand great heat and drought and is therefore recommended as an ornamental park and garden shrub in the more arid sections of the United States. The above photograph was taken on a hillside near Tiflis, Caucasus, Russia, April 24, 1910. (Figure 6.)

nite enough, but I told him I had received them so from the acting chief of police in Pendshikent. Well, he let us go on. Half an hour later, however, a messenger came to us, informing us that we had to return, as the administrator did not feel he could let us go on any further. The acting chief of police in Pendshikent had made a failure of the document that he gave me, having forgotten to mention the exact date and number of my permission from St. Petersburg and he (the civil administrator), being held responsible for the district I was travelling in, could, under those circumstances, not allow me to go on any further.

RETURN NECESSARY.

He said he would allow me to stay there in this village, until a messenger had arrived from Samarkand, as he would investigate this affair; if things were found to be O. K., I could proceed farther on; if not, I would have to return under guard. I had a short conference with my men and then told this administrator that as it might take a messenger to and from Samarkand from five to ten or even twelve days before I could have been cleared of his suspicions, and as my caravan alone cost me from fifteen to twenty roubles a day, I had to decline his offer, but wanted to return by another road to Samarkand

THE PARADISE APPLE AT HOME.

This bushy apple (*Malus paradisiaca*), apparently a native of the Caucasus, is now widely grown all over the world as a grafting stock for dwarfing apples. Mr. Meyer believes it has still a useful future before it as a factor in producing a strain of bush apples suited especially to regions where the summer temperatures are too high for ordinary apples. Photograph made at Geok-Tapa, Caucasus, Russia, April 11, 1910. (Figure 7.)

and investigate this matter myself and find out who was responsible for this mishap. Well, he was kind enough to allow this and as I promised him I would not escape, I didn't even get any guard sent with me.

And so we left that village of Peki on Tuesday, July 12, 1910, went for the whole day along an extremely bad road where often the path went simply over sticks and poles, put slantingly in the rocks and covered over with brush and dirt. We wound along the roaring Zarafshan river, sometimes level with the water, then again several hundred feet above it. Tales of accidents had made us apprehensive of the great dangers of this road, but, thank Heaven, nothing occurred save that the baggage looked less respectable in the evening than it had done at the outset. We had to employ three porters at the most dangerous points to carry the more valuable baggage, for it was too unsafe to allow it to remain on the packhorses' backs, especially my satchel, in which all passports and valuable papers are stored. If, for instance, my letter of credit, together with the passports, had gotten down in the deep, I could almost as well have shot myself, the more so as 1,000 roubles in paper money was also among its contents. It is my policy to have all my valuable belongings in only one receptacle, which has to be strong, not to be too heavy to be carried easily

by one person, but also not to be so light that one can easily run away with it; and this piece of baggage always has to be taken care of the very first thing and is always at night at my own head. Well, we passed this road, which is one of the worst I have seen in my life, safe and sound, and slept that night beneath old apricot trees in the court of a local dignitary in the prosperous town of Orono, situated in the rich valley of the Zarafshan.

WILD VEGETATION SCARCE.

On Wednesday, July 13, we followed the Zarafshan the whole day and passed several villages, where orchards of apricots, mulberries and walnuts intermingled. Wild vegetation, however, is almost absent. In a naturally dry climate, the long occupation of men has exterminated what little there formerly grew upon the mountain slopes and in the glens and today everything is scorched and barren.

On Thursday, July 14, we left the town of Langar, where we had stopped for the night, and passed through a region where almost no level spot was found at all; everywhere mountains and precipices, all rock and cliffs. As a result no villages have been established, and as distances are too long for peasants to carry away woody vegetation to their homes, we found lots of interesting plants: Pistaches, almonds in three species, *Prunus divaricata*, maples, junipers, coluteas, etc. In the herbarium material I sent off a few weeks ago, you'll find many labels bearing the date July 14, 1910. As I had to do all the collecting myself, my men not being intelligent enough for it, I was rather tired that day and was glad to sleep again on the porch of a Muhammadan mosque, notwithstanding a strong wind blew all night through the tall walnut trees and made one dream of storms at sea and fights in forests.

Friday, July 15, saw us leave Wishist, and late in the afternoon we came back again in Pendshikent, where our early return caused lots of surprise, since we had said we would stay out at least one month. And now we went to the police again and found out my name had been booked, but that the acting chief of police was at fault. Then the horsemen to whom I had paid 100 roubles in advance, besides having lent them money on the road, wouldn't return the money and we had to ask the assistance of the police and a judge to get most of it back; even at that I lost twelve roubles on the transaction, besides finding it an extremely unpleasant business which lasted all through Friday evening and Saturday, July 16. The guide, to whom I had given some money, too, got dead drunk and made troubles worse. Yes, this whole trip was tragi-comical! It is good that I am sufficiently hardened off to stand a wee bit of trouble, otherwise such matters are able to make one lose temper and sense.

SECOND DEPARTURE.

On Sunday, July 17, we left Pendshikent again by cart and after a long day's ride we arrived in Samarkand at nine p. m.

On Tuesday next I went to the governor of Samarkand and complained verbally about this treatment I had experienced at the hands of his subordinates. He was a very kind man, had investigations made straightway, and in less than an hour I had a paper in my possession giving me full rights to travel in the same district from which I had been chased out. The very administrator who had been so suspicious, was smiles all over, and pointed out places on the map where many plants were found, and even offered to collect material. And there the matter rests.

When in Samarkand, my interpreter in the meantime had found out that certain things had been taken from his dwelling, while he was absent, and he made this as an excuse for not being willing to go any longer with me, although I knew that it was the hardships and the want of the "flesh pots of Egypt" that made him stay back. He promised, however, to accompany me to Tashkent and find me another interpreter, but after having had private troubles at home, he did not want to do that either, and left me wholly alone. Now I could have gone to the police and forced him to stay with me, as I had a witness that I had engaged him for at

DESERT POPLAR OF TURKESTAN.

A species (*Populus pruinosa*) which is widespread and extremely hardy in Turkestan. It is mixed with tamarisks, which are the low shrubs in the photograph. It also grows widely side by side with *Populus euphratica*, which it considerably resembles. It is one of the most recommended drought-resistant trees for arid regions with scorching summers and mild winters; needs almost no water; but is, unfortunately, difficult to propagate. The wood is hard and durable. (Figure 8.)

least one month, but I had in mind an old Dutch saying: "Mit onwillige honden is't slecht hazen vangen" ('tis a bad job catching hares with unwilling dogs), and in my work especially, if people don't put a little sympathy into it, one gets almost nothing accomplished at all.

AT THE RAILWAY TERMINUS.

ANDISHAN, TURKESTAN, RUSSIA,
Oct. 4, 1910.

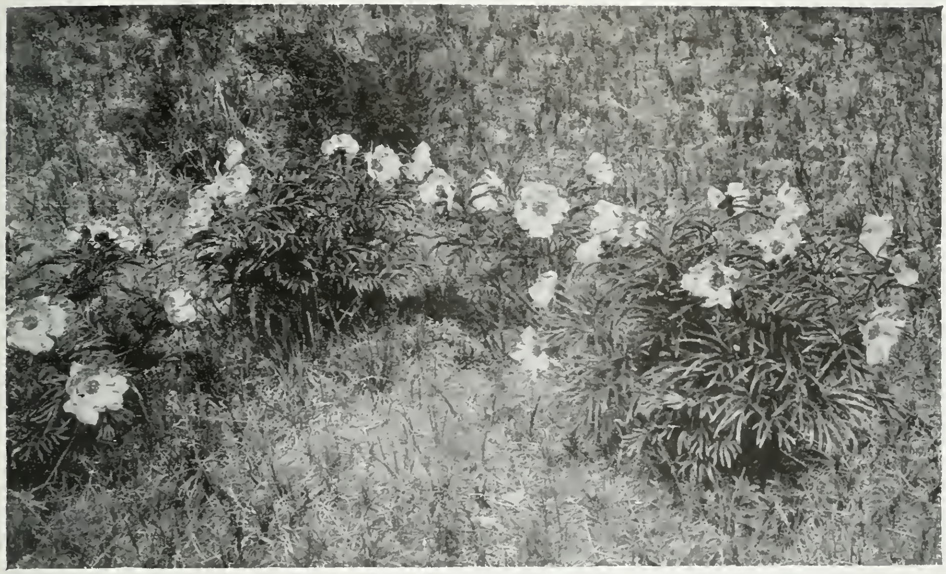
As you see, I am now at the terminus of the Central Asian Railway, and will write you from here a short report of what passed over our heads these last weeks. We changed our plans and instead of going alone on Monday, with a Chinese interpreter, and taking the train, we hired a wagon and went on Tuesday, September 20, 1910. The reasons for going by wagon were many. Firstly, I have an awful amount of baggage (close upon 1,200 lbs.), which is very inconvenient to ship by rail, the more so as some of it is not accepted by the railroad unless crated, and that is too much work; secondly, my interpreter is a new man, whom I know only slightly, and there is no better chance of learning a fellow's characteristics than by subjecting him to a roughing trip; for the Chinese interpreter it was also not bad to learn how to travel in Russian Turkestan. Then in addition came the fact that I could study the country better by cart than from a train window, and last, not least, my health hadn't been of the best in Tashkent, and such a cart trip would make me all right again.

Well, all things went as well as they could. In three days' time we covered the distance from Tashkent to Khodjent, passed through rice fields, fruit gardens, deserts, etc. It is exceedingly difficult, however, to inspect fruit or vegetable gardens close by, as all the plantations are surrounded with high mud walls and strangers are not admitted. Then we also had difficulties in obtaining sufficient food in daytime, as Ramadhan, the Muhammadan month of fasting, was in progress. This incomprehensible religious feast allows no Mussulman to partake of food and drink as long as the sun is in the skies. As soon, however, as that body sinks down, then eating and drinking commences and merriment is made until the break of day. The main meal is eaten then between eleven p. m. and one a. m. What use this unhealthy rule has is as yet a puzzle to me, but this is certain, that it is most inconvenient to all travellers and even to the believers themselves. We often couldn't get a cup of tea, even in daytime, and ready food was quite out of the question.

PEACHES UNDISCOVERABLE.

On Friday, September 23, we stayed in Khodjent and wanted to find some famous peach varieties. We were, however, unable to find anybody willing or capable to show us around, and it was a Muhammadan holiday besides, so we had to give it up. Our wagon driver had become dissatisfied with the expensiveness of feed for his horses and wanted an extraordinary price before he would go any further, although we had engaged him for at least as far as Kokand. Well, we wouldn't give in, and engaged two local two-wheeled carts and left the next morning, September 24. On Monday, September 26, we landed at sunset in Kokand and had our first clean-up in seven days. The last three days we had passed most of the time through sandy, stony and alkaline deserts, going sometimes axle deep in dust, so we and the baggage were simply covered with gray and brown coats of desert dust. At the Russian hotels we tried to find accommodation; they were suspicious of us and we had some trouble of getting a roof above our heads. We had to give our passports the very first thing, apparently to satisfy the fear that we were robbers, returning with loot!.

In Kokand we stayed two days, inspected bazar, seed and grain market and looked over the fruits. Kokand is reputed to be the finest market in Central Asia, and I really expected to find many new things. There is, however, not as much in our line as one might wish to see. I got some samples of unusual varieties of almonds and a large brown chickpea which I had not seen before. There were also very fine speci-



WILD DESERT PEONY.

Unidentified species having medium large, carmine flowers and glossy, gracefully cut foliage of a dark green color; found growing on rather stony and sterile places in Turkestan. Sent to the United States by Meyer as a spring flowering plant for gardens and parks in the northern United States. (Figure 9.)

mens of pomegranates to be seen; that is, of fine color and size, but of very sour taste. Of grapes, the beautiful rosy-white *Ghusaine* table grape was very fine with its long, translucent berries, which taste remarkably sweet.

In the immediate neighborhood of Kokand one sees field after field covered with cotton, alternated with alfalfa and "jugara." This last can stand considerable alkali and may be of some value in alkaline regions with long and hot summers. One also notes the masses of Oleaster trees that are everywhere around the fields and along watercourses. These Eleagnus trees exhibit a remarkable variation in general habitus, productivity and sizes of fruits. The bigger part of them all seem to be seedlings, and are planted apparently only as shelter material; at least the fruits of many are too astringent to be edible, and even of the larger fruited forms, only here and there are the fruits collected. It is, however, a beautiful tree in the landscape, especially the silvery-white forms with the narrow, long leaves.

CHOLERA ENCOUNTERED.

On Thursday, September 29, we left Kokand by train, after having packed our baggage so that the railroad could accept it. In the afternoon we arrived in Margelan, a town where the governor of the Ferghana Province resides. (The name Margelan was changed last year into that of Skobelevo, but men persist yet in calling it by the old name, although the native city of Margelan, where only Sart people live, still retains its old name.)

We left Margelan in the afternoon of October 1, and arrived at evening in Andishan, where I have been writing these last days. We saw the police, of course, or rather were requested to come, and as *my* papers are in good shape, the German interpreter is allowed for the present to stay too, but we had to whisk our Chinaman away to some native inn, where he keeps company with a few fellow countrymen and eats with them. There is much cholera here in this place, and we are very careful with our food. Yesterday I believe

AN ORNAMENTAL EREMURUS.

Unidentified species from Kulikalan, province of Samarkand, Russian Turkestan. Its spikes of rosy pink flowers often reach a height of four feet. The plant is found at an altitude of 7,000 feet in rich, black soil, and is able to stand both drought and cold. (Figure 10.)

seventeen people died here from this dreadful disease, but in fact there may die many more, for the fanatical Muhammadan population persists in hiding cases of sickness and drinks water from polluted places as if there were not such things as bacilli. The summer lasts very long here. All the trees are still in full leaf, and where some have fallen, it is not from cold, but from drought. I hope we'll soon get a cold spell, so that I can send some scions and cuttings of various things.

My present interpreter is not a genius, but I'll see how we can plod along. Turkestan certainly is an extremely difficult country to move about in; the moment one leaves the railroad questions are being asked, and for every little excursion special permits are necessary. I wouldn't advise any one to select this land for a holiday trip, and I have to restrain myself not to leave this whole territory as it is and live somewhere in more peaceful surroundings.

Well, one or two more days and I'll leave by cart for Osh, from there by packhorses to Kashgar. Some robbers are reported to be on the road, and they murdered some people here these last two nights, but a botanical collector is generally exempted from those annoyances.

New Publications

PRODUCTIVE HORSE HUSBANDRY, by Carl W. Gay. Philadelphia and London, J. B. Lippincott & Company, 1914. Pp. xv. + 331, $1.50.

Professor Gay of the University of Pennsylvania states that his purpose in writing this volume was "to emphasize *industry* as applied to horses." His treatment of the principles of breeding is, therefore, summary and wholly practical. The book should be of value to anyone taking up horse breeding as a business.

THE CULTURE OF BLACK AND SILVER FOXES, by R. B. and L. V. Croft. Woodstock, the Rod and Gun Press, 1913. Pp. 83, 60 cents.

This is the latest handbook produced by the amazingly rapid development of silver fox breeding on Prince Edward Island, and is destined for those taking up the work as a money-making proposition. Hence it is primarily of practical nature, but the authors have inserted a considerable amount of theoretical discussion of heredity. They consider the silver fox the product of variation and isolation, not of hybridization, and declare that the coat color is never blended in inheritance, but either "particulate" or "exclusive." Their data, however, show that many factors must be concerned, and they admit that no systematic experiments have been undertaken to discover the ancestry of the present valuable breeds of foxes.

The Immigration Problem

We have an opportunity which is unique in history for the practice of eugenic principles, immediately and on a vastly greater scale than is possible in the case of any other nation. By selecting our immigrants, through proper legislation, we can pick out the best specimens of each race to be our fellow-citizens, and to be the parents of our future citizens. The responsibility which rests upon us in this matter is overwhelming.—Robert DeC. Ward: The Crisis in our Immigration Policy (Inst. Quart. Ill., IV, 2, 1913).

BREEDING KARAKUL SHEEP

Industry Only Six Years Old in the United States, but Attracting Much Interest—Difficulties of Securing Stock—Six Classes of Karakul Recognized in Asia, All Owing Their Origin and Color to the Small, Black Danadar, Now Almost Extinct.

Dr. C. C. Young,
Belen, Texas.

THE Karakul sheep industry is one of the most recent enterprises in live stock in the United States, but few branches of this department of breeding are attracting more attention today. I propose, therefore, to give in this paper a history of the introduction of Karakul sheep into North America, an account of the present status of the industry, and my belief as to the origin of the six classes which, in Central Asia, are recognized as making up the breeds known to the Russians as Karakul and to the Bokharans as Arabi.

The industry in the United States dates back only to 1908, when a letter of introduction from President Roosevelt to the United States Ambassador at St. Petersburg enabled me to interest his excellency A. S Yermaloff, exminister of agriculture of the Russian empire, and now a life member of his majesty's council. Through his influence I secured the cooperation of the Poltava Agricultural Society, which obtained for me fifteen head of Karakuls in Bokhara.[1]

The laws of the Khanate of Bokhara prohibit the exportation of these valuable fur bearing animals by foreigners, but a few flocks have been gotten out by certain Russian societies, who have received the support of the Russian Foreign and Agricultural Departments. Although Bokhara is a quasi-dependency of Russia, the czar does not interfere in the international administration of the emir's empire, which has an absolute monopoly of the Persian lamb and Astrakhan fur industry.

The Russian government also prohibits the importation of Karakul sheep, and as the United States government generally does not permit the importation of live stock from Asia we have found it an almost impossible task to start the industry on this continent, although our efforts extend over a period of fifteen years.

THE FIRST IMPORTATION.

In the beginning of 1909, five rams and ten ewes arrived in New York on a Saturday boat, which was scheduled to return on Monday, and had it not been for the prompt intercession of the Hon. J. A. Tawney, whom we happened to reach at the last moment, and who secured the cooperation of the federal authorities at Washington, my Karakuls would have been slaughtered or returned on the same boat.

The sheep were in quarantine for a long time, and for three months were kept in an absolutely dark barn, in order to lower their power of resistance, and to make it possible to trace in the blood the parasite of surra. When flash light photographs reached us, showing the animals to be in a very emaciated condition, we at once applied to Mr. Roosevelt, who ordered their release.

I returned in May last from a year's

[1]Those interested may refer to the American Breeders' Magazine (third quarter, 1912), Literary Digest (September 30, 1911), and the New York Herald (September 10, 1911 and April 20, 1913) for further details about my importations.

A FULL-BLOOD KARAKUL RAM.

Teddy junior, shown above, is a son of Teddy senior, the famous ram of Dr. Young's first importation, who, after being kept at Wichita Falls and Middlewater, Texas, is now at Prince Edward Island. Teddy junior died at the United States Department of Agriculture's experimental farm near Washington, D. C., last year, when accidentally kicked by a zebra. (Figure 11.)

trip to Central Asia, and succeeded in bringing with me another herd consisting of seventeen Karakul sheep, one four-horned, fur-bearing Karachaev ram, and one enormous red Kalmik fat-rump ram. The quarantine regulations were less rigidly enforced, but the dipping of the sheep in cold weather cost me the life of the best ram of the lot.

When the sheep of my first importation finally reached our ranch, near Wichita Falls, Texas, we noticed that the fourteen accompanying lambs which were born in transit did not have the expected lustre and tightness of curl, the only exception being two of them, which fully measured up to our expectations.

My father, who has been raising Bessarabian Tshushkas (grade Karakuls) near the Black Sea for a great many years, and who criticised me severely for risking thousands of dollars on a few sheep, remarked that I had probably thrown my money away, as in his opinion the climatic conditions of Bokhara were essential to the best lamb fur raising.

As the two ewes that produced the best lambs seemed in a little better physical condition than the rest, we concluded that in another year when all the sheep would be in better physical condition, the result would probably be more satisfactory.

During the entire year the sheep were well fed, and in the summer months they enjoyed the best of pasture,

but when spring came, notwithstanding the fact that the ewes had been bred to the ram which seemed in the best physical condition, the lambs did not show the improvement from a fur standpoint which we expected, except those lambs which came from the two ewes that the previous year gave us two good lambs.

FLEECES DETERIORATE.

A careful examination of the curls of the lambs of the two good ewes showed, however, that there was less lustre than the year before, and less tightness of curls, and my father remarked that we would probably find that the same Karakul sheep which gave us excellent result in Bokhara would fail us in Texas, where the climatic conditions were different, especially as far as rainfall is concerned.

The third year showed considerable improvement, especially with the two good ewes, which gave excellent results. We then began to study the original five rams and noticed that the character of the wool was not the same, and that Teddy, named in honor of Roosevelt, and another ram had coarse long wool, whereas the others had two classes of wool fibers—a long coarse gray wool, in which was hidden a fine lustreless short reddish wool resembling microscopically that of our Merinos. To our great surprise we found that the two good ewes also were free from the fine underwool. The next year, we satisfied ourselves absolutely that the fine wool present in most of the sheep was entirely responsible for their inferior fur-producing qualities: We named sheep which contained this fine wool "Karakul Finewools" but later, when we found that this fine wool came into the strain through the admixture of some fine-wool-bearing Afghans, we changed the name to "Karakul-Afghan."

It was quite by accident that I found out that by breeding Teddy to the Karakul ewes fairly good results were obtained, especially from those ewes that had less fine wool in them; and in one case a Karakul-Afghan ewe that had but little fine underwool, which was bred to a son of Teddy, himself not entirely free from fine wool, gave us a fair lamb, which was exhibited in Omaha in 1911 by Joseph F. Simonson.

A number of other tests finally convinced me that a very small amount of fine wool can be overcome, and considerable fine wool in ewes can be neutralized, where the ram is entirely free from the short fine underwool. Two crosses suffice to breed it out entirely.

DIFFERENCE IN CROSSES.

Where we crossed Merinos and Shropshires with Teddy, a very inferior skin was produced,[2] in which there was great lack of lustre, and a very imperfect curl formation, giving the skin a matty appearance, valueless from a fur standpoint, but excellent results were obtained when the same ram was bred to such of our lustrous longwools as Lincolns, and such red Persian fatrumps as were entirely free from short wool, and possessed very coarse wool.

Where Teddy was bred to longwool ewes, free from fine wool, and the skins of the lambs were obtained the first few days after birth, they showed tight curls uniform in size and posessing the required lustre. Such half-blood skins were valued by Pretorius and Thorer, assisted by Henry Basch of New York, to whom we were referred by the Department of Agriculture, at from $8 to $12 per skin. In all cases where the prices ranged from $3 to $4 the skins showed lack of lustre and curl formation, which was easily traced to fine wool, either in the Karakul rams or grade native longwools. The Middlewater Cattle Company, which purchased all the so-called Persian sheep of Col. Charles Goodnight, found that these were valueless, except where the ewes were free from fine underwool, and only where Teddy was employed were the results satisfactory—in fact, most of the $12 skins were halfblood Karakul-Persians.

The red Persian fatrump, erroneously called broadtail, and sometimes fattail,

[2]The second cross is greatly improved.

THE CURLIEST LAMB BORN.

ull-blood Karakul lamb four days old. The father is Teddy senior, the property of the Middle-water Cattle Company; the mother is a full-blood Karakul ewe, but has some fine wool in her fleece. Little of this is evident in the lamb, however, bearing out Dr. Young's contention that a small amount of fine wool in the ewe can be neutralized by a prepotent, decidedly coarse-wool ram. Note the tight curls of the lamb, extending from the tip of its nose to the end of each extremity. Photograph furnished by Joseph Simonson. (Figure 12.)

is a very hardy mutton sheep, belonging to the species of *Ovis steatopyga*, and is closely related to the Kalmik, Mongol, Khirghiz, Tshuntuk and other fat-rump (Kurdiuk)[3] breeds, that have very coarse, brittle, generally red wool but possess no fur characteristics whatsoever, unless they are crossed at least once with Karakul rams of the right class. The furriers, who in their ignorance call Karakul skins (either full-bloods or grades) "Persians," "Persian Baby Lamb," "Persian Broadtail," or "Astrakhan," furnish the opportunity for certain breeders of red Persian fat-rump sheep to dispose of their stock as "Persian broadtails, the only genuine fur-bearing sheep that produce the famous Persian and Astrakhan furs." To corroborate these statements readers may consult a book on Russian breeds of sheep, issued by the Russian Imperial Department of Agriculture, also a circular recently issued by the United States Department of Agriculture.

From the two good ewes and Teddy there were born three rams, one of which was used one season by the United States Department of Agriculture on the experimental farm near Washington, D. C., and there lost his life from the kick of a zebra. Another good ram died on a ranch in Texas, from eating green alfalfa. The third ram became the property of the Middlewater Cattle Company, controlled by former Congressman Frank O. Louden of Illinois, and was finally bought back from them by ourselves, and is now on Prince Edward Island, where we have decided to establish our Karakul industry. The fourth ram, a grandchild of Teddy, was sold by us to the University of Edinburgh, but has not yet been delivered.

KARAKULS IN AMERICA.

The father and grandfather of these four rams—Teddy, Sr., the only good ram of the first importation—is the property of the Middlewater Cattle Company, of Middlewater, Texas. The second coarse-wool ram of the first importation, when crossed to good Lincoln ewes, gave fair results, and is today our property on Prince Edward Island

About three years ago, the entire herd, with the exception of three Karakul fine-wools that were purchased by R. J. Rhome, of Texas, was divided equally between the Middlewater Cattle Company and myself, but I have since sold my share, telling the purchasers of the urgent need of breeding out the obnoxious fine wool strain by the introduction of new Karakul coarse-wool blood of the second importation which landed in Baltimore in March, 1913, before offering any for sale. My advice, however, was disregarded. I strongly urge breeders to be cautious in buying rams. The officials of the U. S. Department of Agriculture at Washington seem fully alive to this danger, and in a recent circular letter advise the purchase of tested rams only.

Out of the second importation, six rams and four ewes were purchased by the Hon. Charles de Bremond of New Mexico, I retaining an undivided half interest in them; the balance are the property of the writer and his associates in Charlottestown, P. E. I., Canada. where black silver foxes and other fur-bearing animals are raised with wonderful success.

We find in Central Asia six classes of Karakul[4] sheep, all of which owe their black pigment, tendency to tight curl formation, and lustre, to the small, black, and nearly extinct Danadar sheep. These breeds are known as (1) Large Arabi or Duzbai, (2) Small Arabi, (3) Intermediate Arabi, resulting from the crossing of the above mentioned three classes, (4) Gray Shiraz, (5) Zigais (of these classes there are very few), (6) Karakul Afghans, which last class unfortunately comprise 90% of all the fur-producing sheep in Bokhara, and while possessing excellent mutton qualities and wonderful hardiness, like all of the other breeds, can hardly produce profitable fur in America, where people

[3]Kurdiuk is the Tartar word for "fat rump."

[4]Kara Kul, "Black Lake," is the name of a town in Turkestan, where these sheep have long been raised. It has given its name to the whole breed, through its adoption by the Russians.

A STUDY IN HEREDITY FOR FUR-LAMB PRODUCERS.

At the left is a section of the skin of a half-blood Karakul lamb a few days after birth. Its sire was the full-blood Karakul Teddy, the only first-class ram in the first importation; its mother was a Lincoln ewe. Note the close, tight curls, and the lustre of the hair—on these two points depends the trade value of the skin. This particular specimen was valued at $12 by trade buyers in New York. At the right is the skin of another half-blood Karakul lamb four days old; its father was also Teddy, but its mother a Merino. The fine wool introduced by the Merino ewe has ruined the curl formation and lustre of the skin, making it practically worthless. From these two skins of lambs, both from the same father, it is easy to decide that a long-wool is superior to a fine-wool in crosses with Karakuls for fur production. (Figure 13.)

demand the best quality of the Persian furs, unless, as already explained, the rams belonging to this class are eliminated and the substitutes which give us the best results are chosen from the first mentioned three classes, thus enabling us to breed out the obnoxious fine-wool strain, if it exists.

Karakul-Afghan rams bred to English longwools give us a better fur than when crossed with Karakul-Afghan ewes—in any event the dullness is in a large degree overcome—but unfortunately, the curls are not tight enough, and there is also a lack of uniformity in the size of the curls. The average price of these skins is $3.50.

The following are the physical characteristics of the Duzbai Karakul: A large animal, the size of our Lincolns and even larger; large head, with very convex nose line; long, drooping, pendulous ears; some have large horns, others have none; strong, thick feet; immense broad tail, consisting of some eighteen vertebrae. At maturity it has coarse, long, gray wool on body, with coarse, stiff hair, that remains black even after maturity and with absence of fine under wool on head, face, feet and abdomen. At birth the lamb has, for about two weeks, beautiful, lustrous, black curls. It is this breed that the Russian Government bulletin, issued recently by Karpoff, mentions most prominently, speaking of our work in connection with it.

THE SMALL ARABI.

The physical characteristics of the small Arabi are: It is much smaller than the Duzbai, has thin feet, small head, straight nose line, short erect ears, long, slender, triangular tail, coarse, long, gray wool at maturity, with absence of fine underwool. At birth lambs come with beautiful, tight, black curls. Occasionally one of these animals remains black, even after maturity, and this led me to the discovery of the origin of all the Karakul breeds, which is the black, lustrous Danadar,[5] a few of which are still found in Khiva, Bokhara and Thibet, according to native report which I question.

Sometimes the coarse, hair-like wool, is as fine as that of our Lincolns and has great lustre, but when it lacks lustre it may be easily mistaken for Afghan short, fine wool. The difference in the length, however, always tells the story. So does the microscope. At birth the lambs come with very tight and lustrous curls.

The intermediate class is, as its name suggests, a mixture of the characteristics of the Duzbai and Small Arabi. As already mentioned, the Small Arabi is the best of these classes; but as the Duzbai is also highly satisfactory, and when bred to our native sheep gives an increase in weight and greatly improves the mutton qualities, as is shown in Armour's test, it is probably advisable to choose from these animals.

In selecting breeding animals, the essential thing is to avoid those with short, fine wool, that can be seen at a glance. The coarse, gray, long wool sticks out, and hidden in it is the short, lustreless, fine-wool, from the Afghan sheep, which I believe is the ancestor of the Merino. Generally the fine wool shows on the head, face and abdomen, and is without lustre, and brown, instead of black.

The few flocks that have been gotten

[5]That the Karakul breeds have not descended from the Small Arabi, as certain Russian investigators state, I am absolutely sure. It was my good luck to find in England a furrier who sold the last Danadar skin 47 years ago, at which time there were no Persian Lamb, Astrakhan or Krimmer furs in the trade. F. N. Petrov, dragoman of the Russian embassy at Bokhara City, secured for me a gray Danadar skin (produced by a cross between the original black Danadar and the white Afghan fine-wool) and also sent me a photograph, made by him north of Bokhara City near the border of the Khanate of Khiva, and an examination of this skin and photograph will, I believe, convince anyone that my theory of the origin of the Karakul from the black Danadar is correct. Mr. Petrov also sent me a photograph of a supposed black Danadar at the present day; it does not convince me, however, that such an animal still exists. The tail of the sheep photographed, although not typically broad, is not long, as it should be, while the curls of the wool are excessively tight, resembling those of the Small Arabi. On my trip to Turkestan this summer I hope definitely to settle the interesting question of whether the black Danadar yet exists as a breed.

out of Bokhara in the past few years were, without exception, taken from settlements near the railway stations of Tjardjui, Kara-Kul and Bokhara City, where the chances of inbreeding are great. Practically all of the Karakuls were gotten out by representatives of Russian agricultural societies, to whom it did not seem to matter how many good, unrelated animals they could get for the meagre sum advanced them, but what number they could bring back in total, good, bad or indifferent, no matter whether inbred or not. Their chief anxiety seemed to be to avoid the reproaches of their fellow members, each of whom wanted some sheep; and unfortunately, these fellow members, although much nearer to Bokhara than our breeders, have nevertheless, just about as hazy an idea of the expense and difficulties to be overcome in the Kara-Kum desert as the average American sheep raiser of our Eastern states has.

DIFFICULTIES OF TRAVEL.

It is one thing to buy a few sheep in the oases close to the railroad, where one does not have to carry water, and quite another when it comes to fitting up a costly caravan and undertaking trips into the interior for hundreds of miles, carrying numberless burdiuks (water sacks), provisions, ammunition, bedding, utensils, and employing rather expensive subordinate officials, who can make a native sell one the sheep he desires, *providing one is fortunate enough to know a good Karakul when he sees one.* I have seen practically every sheep that has been gotten out of Bokhara into European Russia, and the good animals represent a negligible quantity indeed. When I was asked to separate the largest herd in European Russia, numbering nearly three thousand, I found 112 head among them that were more or less free from fine wool; but they were too closely inbred, which makes the wool fibre very fine, resulting in a cheap, open-curled, instead of tight-curled, high-priced skin. From this, it must be evident that European Russia at present is hardly the proper place to buy unrelated breeding animals. and as for those few Karakuls that have been gotten into Germany and Austria, I am sorry to say that they do not even deserve mentioning.

It is the practice of the Russian societies to raffle off all specimens imported, which makes it impossible for their members to put even a short distance between one ram and another. In fairness, however, I must state that last year Messrs. Karpoff and Ganko made the first effort really worth mentioning, when they went as far as to the steppes Djom-Boss in the district of Kerki, some 200 miles from Tjardjui, and brought out quite a flock; but most of them had the undesirable short underwool and again, they were raffled off amongst the members of the Poltava Agricultural Society. I was surprised when I found that practically none of Russia's breeders understood the danger due to the presence of fine wool.

In Mr. Ganko's excellent report, delivered to the Russian Sheep Congress at Moscow last October, which I attended, no mention was made of this all important fact until I reported the result of my tests with finewool American sheep.

HINDRANCES TO FOREIGNERS.

Providing a Russian subject can secure permission from the Russian Department of Agriculture, and the Department of Foreign Affairs gives its consent, and providing his majesty the emir permits him to enter the Khanate, it is only a matter of being properly financed, and a limited number of Karakuls can be obtained, although, after all, the proper Jigit (an official of the district governor, who can do what he pleases with his subjects) is indispensable.

A foreigner can not get out Karakul sheep for the following reasons: (1) Even after securing permission from the Russian war minister to enter west Turkestan, which often means weeks of delay in St. Petersburg, he is not permitted to go very far away from the railway station, and he absolutely can not go to Takta Bazar, Kushk, Kerki, Termez or Karshi.

(2) The emir does not permit a foreigner to export Karakul sheep, and should he get them into European

Russia through a third party, he can not get them out lawfully.

(3) Most European countries prohibit the importation of live stock from Asia, on account of certain diseases, and especially is that true of England, the United States and Canada, where it is nearly impossible to secure a permit to land them. Even where an exception is made for purely experimental or exhibition purposes, the most rigid quarantine is imposed, lasting for months. Those foreigners who have travelled in Russia with proper credentials showing them to be interested in scientific research work will testify to the great courtesies shown them by Russian officials, and this explains why I have been able to get out a few head of Karakuls. But on account of the mistakes which I made in my first and, to some extent, in my second importation (for I suspect that some of the animals in the latter were related, after all), I hope to secure permission to export a few more sheep direct from Bokhara. During my last visit there, I did not learn certain facts about the source of the Karakuls which I bought until after I had used the permit given me by the U. S. Department of Agriculture, and had already forwarded to America the sheep which I later discovered might possibly be inbred, in some cases at least.

I expect soon to leave for a third trip to Asia, where I hope to secure permission from the emir to export a few more sheep for scientific experiments, and I trust that this time I will be permitted to make my own selections over a vast area, thus being able to put such a large distance between the source of one animal and another, that the chance of getting related stock will be remote and negligible. Of course, as a preliminary, everything depends on my getting a permit[6] from the U. S. Department of Agriculture to bring the sheep into this country—a privilege that has already been denied to me by the chief medical officer of the Canadian quarantine department at Ottawa.

Though not permitted to enter the forbidden zone of Bokhara and Transcaspia last March, I hope to be able to do so this time, as it is the opinion of the Russian Department of Justice that since I became naturalized in America without the permission of the Russian government, I am, technically, still a Russian citizen, who needs but return with a Russian passport in order to enjoy all the rights and privileges of Russian citizenship.

[6]Dr. Young secured the desired permit and left for Asia in February, after completing this paper.—THE EDITOR.

Quail Breeding

Experiments in the propagation of game birds have been successfully conducted this summer on the estate of William Rockefeller at Tarrytown, N. Y., under direction of Herbert K. Job, State Ornithologist of Connecticut. A man secured by Mr. Job was employed and carried on the work under his direction. No attempt was made to raise a large number of any one species, the purpose being to work out a practicable system for private estates. About 200 young bobwhite quail were reared to maturity, with trifling loss and no outbreak of any disease. The pheasant rearing was successful. A few broods of the Hungarian partridge were raised, and of the tinnamou, a curious South American game bird, also wood ducks and other waterfowl, and a considerable flock of guinea fowl. Under Mr. Job's system the young were hatched by bantams and the broods allowed free range by day, being shut in at night. They were scattered over the great estate, and the young broods of game birds with their foster mothers were an attractive feature all summer on the wide lawns. Trapping and other destruction of vermin was at the same time carried on.—Forest and Stream.

THREE NEW NUTS

Pili Nut From Philippines and Paradise Nut From Brazil Becoming Favorites in American Markets—Queensland Nut Promises to be a Valuable Commercial Nut Well Adapted to Southern California and Regions of Similar Climate.

THE EDITOR

FOLLOWING an increase of interest in nuts as food among consumers, and in nuts as a crop among horticulturists, several new sorts have appeared on the markets of the United States, and by their excellence give promise of attaining considerable commercial importance. The best known of these is probably the Pili nut of the Philippines, which is now commonly sold throughout the United States at about twenty-five cents a pound, although it has been in the trade for only a few years.

Disregarding some confusion in nomenclature, it appears that the Pili nuts of commerce are the fruit of *Canarium ovatum* and *C. luzonicum* of the Philippines and to a slight extent of *C. commune* of the Dutch East Indies, belonging to the natural order Burseraceae. The genus contains a hundred or more species, and is of Indo-Malayan origin, but has outposts in Africa, China and Australia. It hardly appears probable, from its distribution, that it is adapted to culture in the United States, but it might be made a valuable crop in Central or South America, since in addition to nuts the trees yield a valuable resin, the "gum elemi" of the pharmacopeia, whose stimulating properties are valued in plasters and ointments.

"The texture of the kernel," Barrett[1] remarks, "is almost ideal: it is exceedingly light without being spongy, brittle without being hard, and highly flavored without being oily. It is so easily digested that a kind of infant food is said to be prepared from it, the blanched kernels probably being pressed to remove excess of oil, and then ground.* * * Even the pulpy husk of thoroughly ripe nuts is eaten by Filipinos in some districts.

"It appears that nowhere in the Philippines is the Pili actually cultivated, although in the Moluccas a species which may also occur in Mindanao (*C. commune*) is actually under cultivation."

BREAD MADE FROM THE NUTS.

The nuts of the latter species, although little different from the Pili (*C. ovatum?*) and perhaps sold in the United States under the same name, are in the East known as Java Almonds. Hogg says[2] the tree attains a height of 50 feet, and its nuts furnish an important article of food to the natives; "but they are considered very unwholesome if eaten fresh, which is known by the exterior pellicle being of a pale white color with purple streaks, instead of reddish; and then they cause dysentery and diarrhoea. They are eaten both raw and roasted, and in Amboyna they are converted into bread, which is made in rolls about a yard in length and one inch thick; they are also made into a sort of marmalade. An oil is expressed from them which is used at the table when fresh, and in lamps when stale." The fruits of other species are pickled and eaten like olives.

The oil of commerce, known as Java Almond oil or Canary oil, is secured from a number of species,[3] which are sometimes planted as shade in nutmeg plantations, although the nuts are usually

[1]Barrett, O. W., in Philippine Agricultural Review, November, 1912.
[2]Hogg, Robert. The Vegetable Kingdom. 254. London, 1858.
[3]Krause, M Eine neue Fettfrucht aus Deutsch Neu Guinee. Tropenpflanzer, XVII, 3, 147, 1913

THE PILI NUT OF THE PHILIPPINES.

Commercially it is the most important new nut which has appeared on the American market during recent years. The nuts (here shown natural size) have an excessively thick shell, which demands attention from some tropical plant breeder; but the kernel is so delicate and nutritious that an emulsion of it is frequently used as a substitute for milk in bringing up infants. A valuable commercial oil is pressed from them, while the resin of the tree is the "gum elemi" of pharmacists, used in plasters and ointments. The nuts shipped to America are mostly from forest trees, the genus not being cultivated in the Philippines, although it is in the Dutch East Indies. (Figure 14.)

gathered from wild trees. Pastrovitch found[4] that 65.73% of oil could be extracted with petroleum ether or 56.12% by simple pressure, and he describes the oil as "bright yellow, odorless, of a pleasant, pure taste; it might very well be used as a food fat."

THE PARADISE NUT.

Somewhat similar to the Pili nut is the Paradise nut, a near relative of the more common Brazil nut, and grown in Brazil, Venezuela and Guiana. Its botanical genus is Lecythis, and the species usually shipped to this country is said to be usitata, but it seems probable that several species are used, the principal one being that usually known as *L. zabucajo*. The native name is Sapucaia, and under this name it is sold in Europe, the designation "Paradise nut" appearing to have originated in New York.

The natural order of Lecythidaceae, which embraces not only the Paradise nuts, but the Brazil nut (*Bertholletia excelsa*) and the Cannon Ball tree (*Couroupita guianensis*) is remarkable for the character of its fruit, the seeds being enclosed in hard, woody "pots" or "urns," provided with lids which fall when the fruit is ripe, allowing the seeds or nuts to drop to the ground. The receptacle of the Brazil nut is fairly familiar; that of the Paradise nut, shown in the accompanying photograph, is six inches in diameter, and the lid two inches across. It is frequently called "monkey pot," as it is alleged that the monkeys are able to open it while still on the tree. Barring such agency, when mature the lid opens by itself, the nuts drop, and the pot remains on the tree for a year or two.

FORMERLY A STOCK FOOD.

The tree is common in its habitat, but it is only in recent years that the nuts have attained a commercial value. Writers early in the last century declare they were used only for stock food, much as acorns in the United States, and it is even alleged that the vernacular name, "sapucaia," means "chicken," and points to their former use for fattening poultry. In earlier days, however, there is evidence that they were highly esteemed by the Indians as food, although William Piso, who testifies to this, declares that excessive indulgence in them causes baldness.[5]

They have always been somewhat scarce, because of the fondness of monkeys for them; and for this reason, and the present commercial demand, they now bring three times as high a price as the Brazil nut—75 cents a pound. The preference for them is due to the fact that the meat is considered of a finer flavor, as well as more digestible. The shell, moreover, is thin, in pleasing contrast to that of the Pili nut, which has a way of putting lightly-made nutcrackers quite out of commission.

Most of the 30 or 40 species of Lecythis attain a large size and furnish excellent timber, which is considered particularly resistant to the attacks of teredos and barnacles, in salt water. *L. ollaria*, most commonly known as the Monkey Pot Tree, is said to resemble an elm in appearance. Its bark can be separated into nearly a hundred layers, about the thickness of writing paper, which the Indians commonly use in rolling cigarettes. Its seeds contain 39% of oil; the pot which holds them is widely used as a kitchen utensil. The seeds of *L. lanceolata* are considered narcotic, and usually roasted before they are eaten; those of *L. amara* are too bitter to eat, but furnish a valuable industrial oil.[6] The species is not, to my knowledge, under cultivation, but may eventually repay such culture.

THE QUEENSLAND NUT.

The Queensland nut is more interesting than either of the two preceding, to

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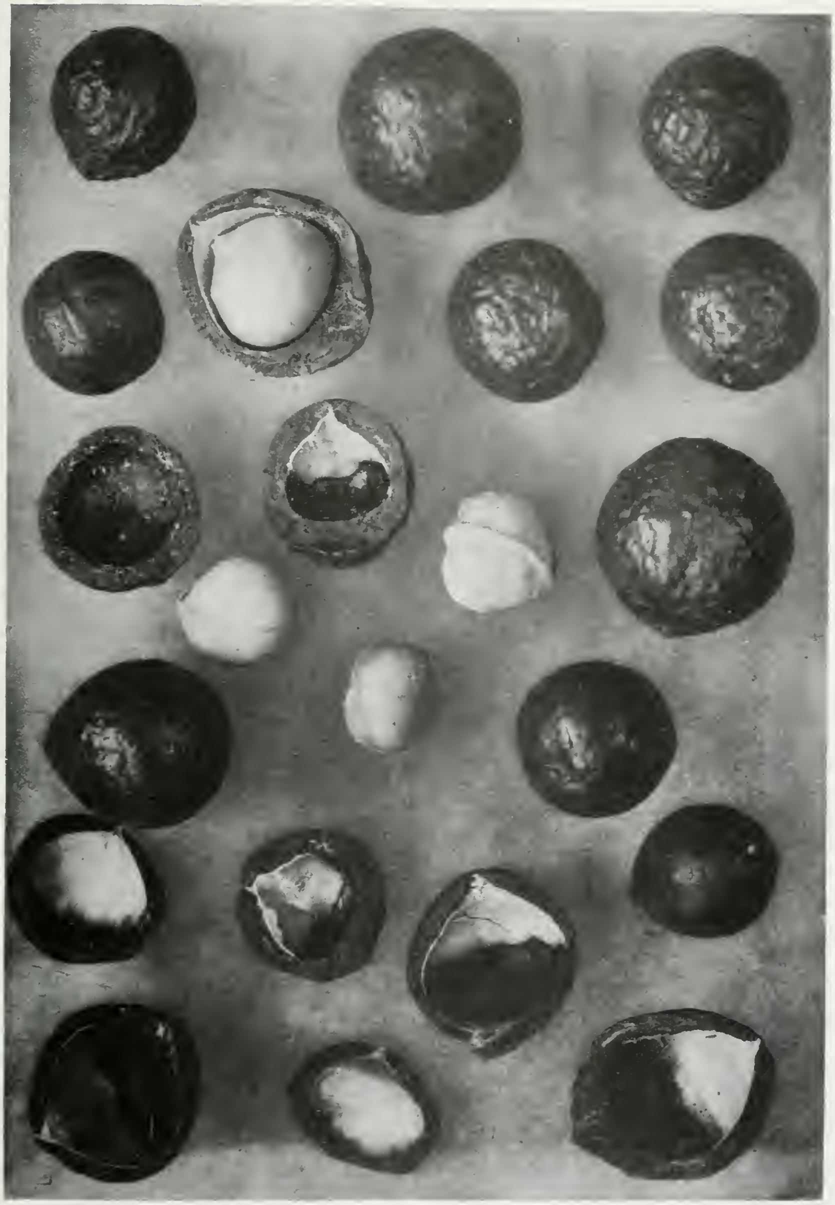
[4]Pastrovitch, P. Chem.-Zeitung No. 65, p. 781, 1907.

[5]Gulielmi Pisonis Commentarium in Iacobi Bontii Historiae Naturalis et Medicae Indiae Orientalis Liber VI, p 135, Amsterdam, 1658. He calls the nut Iaçapucaio and distinguishes two species. "In (calyces)," he says, "continentur nuces jucundi saporis * * * & gratissimum incolis aeque & animalibus suppeditunt alimentum. Sapore & excellentia Pistaceis adaequantur & venerem sopitam dicuntur excitare. Potiones & pultes, tam ad Medicinam quam ad epulas ex illis comparantur."

[6]Flora do Brazil, p. 65

THE PARADISE NUT OR SAPUCAIA.

It is one of the "monkey-pot" nuts of the Spanish Main and the forests of the Amazon, and is now considerably sold in the United States at 75 cents a pound. The nuts, which look much like gherkin pickles, are contained in a receptacle six inches across, furnished with a neatly fitting lid, which drops when mature, allowing the nuts to fall to the ground, while the pot remains on the tree, unless it is brought down by the Indians to serve as a household utensil. The nuts are of a rich but delicate flavor, and easily digested. (Figure 15.)



THE QUEENSLAND NUT.

A delicious nut of Australian origin, which is creating much interest in California. It is resistant to drouth and fairly resistant to frost, and promises to be of much value commercially in the warmer parts of the United States. Extensive plantings are being made, but mostly in an experimental way, or for ornamental purposes. Thickness of shell is the only defect of the nut, and this is one that is easily amenable to improvement by selection. In texture and flavor, the kernel resembles that of a Brazil nut, and is universally liked; small shipments from Queensland to London are said to have been sold at $2.50 a pound. Photograph natural size. (Figure 16.)

the extent that it offers promise of industrial value in Southern California and some other parts of the United States, where it is already being widely planted on an experimental scale. Botanically it is *Macadamia ternifolia*, of the order Proteaceae, and takes its common name from its home; it is also said to be called the Australian hazelnut, although not so known in this country.

The fruit is a drupe with fleshy exterior; the brown kernel (the nut itself) has a shiny surface that is particularly attractive. Its meat closely resembles that of the Brazil nut, but is richer and better flavored; like the Pili nut, it has the disadvantage of a very hard shell, which selection alone will reduce. In flavor it is first-class—small shipments made from Australia to London are said to have brought twelve shillings a pound on the Covent Garden market. Few are sold in California, because of the present small production.

The tree is moderately frost resistant, and requires very little care or water, wherefore it is highly prized in semi-arid localities. Despite this, it will, like other plants, give better results if well irrigated. As the bush or small tree which bears it is distinctly ornamental, and has the advantage of evergreen leaves, it is much favored for planting as an ornament. For this purpose, as well as for its nuts, it can be recommended without hesitation in Southern California and similar regions where its character exactly fits it for the needs of the rapidly increasing number of people who believe that economic value and novelty should be combined with ornamental qualities, in landscape gardening.

Increasing the Richness of Milk

The possibility of increasing, with economic advantage, the average fat content of cow's milk, is discussed by Nils Hansson in the Kungl. Landibruks-Akademiens Handlingar och Tidskrift, LII, 5, Stockholm, 1913. After discussing the results of feeding experiments carried on for twenty-five years at the Central Experiment Station of Sweden, where he is chief of the animal husbandry section, the writer summarizes the results of his investigations on the influence that the choice of the bulls has on the fat content of the milk. He concludes:

1. It is possible to increase the percentage of fat content of the milk of a herd, with economic advantage, by a judicious selection of the breeding animals.
2. By dividing a herd into families of descendants of the sires and of the dams, the influence of each animal on the development of the qualities of the herd may be better demonstrated.
3. The influence of the males is demonstrated by the average production of all their female descendants, or still better by a comparison of the average production of their daughters with that of the dams of these daughters when they were of the same age.
4. The influence of the bulls on the percentage of fat content of the milk of their female descendants depends upon the qualities of the females of the preceding generations.
5. The influence of the cows appears in the fact that a bull possessing a certain genotype percentage of fat cannot increase the percentage of fat in the milk except in the daughters of cows inferior to him in the percentage of fat content, whilst the daughters of the same bull out of cows yielding richer milk will have a percentage of fat inferior to that of their dams.
6. The males and the females transmit to their descendants the percentage of fat which they themselves have inherited from their ancestors, the male and the female having, as it appears, an equal influence on condition that they represent the same constancy of results in this respect. But owing to its larger number of descendants, the male has a greater influence on the development of the herd.

INFLUENCE OF SOURCE OF SEED

Many Minor Characters Dependent on Habitat and Easily Changed Under New Conditions—Apparent Example of Inheritance of Acquired Characteristics In Pines Crippled by Growth in Poor Soil.

ARNOLD ENGLER, [1]

in Mitt. der Schweiz. Centralanstalt. f. d. forstiche Versuchswesen,

(Contributions from the Swiss Central Station for Forest Research) Zürich, 1913; 153 pp., 12 tables.

FOR many years foresters have been occupied with the question whether the characters of climatic races of trees are hereditary, and whether they persist for longer or shorter periods in seedlings which have been raised under other climatic conditions. In many different countries experiments and observations have been devoted to this practically important question, and the work before us is an important contribution to the subject.

More than 70,000 pine[2] seedlings were grown at 12 stations in Switzerland at successive altitudes from 370 to 1980 meters, the seeds having come from localities in northern Europe, in the Alps, in western Russia, in southern France, and from intermediate localities. The seedlings are now from six to seven years old. From data obtained from these cultures and from other observations the author is able to show that characters such as the shape of the scales of the cones, the resinous coating of the buds and the age limit of the needles are in large measure dependent upon the habitat and soon undergo change when the plants are grown in another climate On the other hand he demonstrates that there is an "innate physiological disposition" of the plant which is preserved by its progeny in a foreign habitat and which is expressed, for example, in a poorer growth in an unsuitable climate. Thus, the poor form of the pines grown in Livonia from seed from southwestern Germany is not due to the fact that the seeds came from inferior trees but from the inability of the race to adapt itself to the climate of Livonia. The pine of western Russia, the Riga pine, possesess on the other hand a high degree of physiological adaptability and consequently retains its good habit of growth even in southern France. In contrast to this, pines from middle or northern Sweden when grown no farther from their home than northern Germany are inferior to the native race in growth and in shape.

CORRELATION FOUND.

In the plantings at the Swiss station it was found that in seedlings one to two years old as well as those six to seven years old, the growth in height decreased with increasing altitude or increasing latitude of the locality from which the seed came. An exception is afforded by six or seven-year old seedlings of the Engadine pine (*Pinus silvestris engadinensis*) which even at the lower altitude made a much finer and more vigorous growth than seedlings of the same age of the common pine (*Pinus silvestris*), obtained from lower altitudes in the Alps. At the higher stations this variety surpassed all the other races included in the experiment. Among these the plants grown from seeds collected in France, in southwestern Germany and in northern Switzerland showed an especially poor habit of growth, and those from the two latter localities suffered from dying of the tips because they continued growth too late in the fall. Especial interest attaches to the observation that the seeds of pines which had been crippled by un-

[1]Translation of a review by Büsgen in "Zeitschrift für Botanik," Vol. 5, p. 838, 1913.

[2]*Pinus silvestris* is the species referred to throughout this review, unless otherwise mentioned.

favorable soil conditions gave rise to crippled plants in the experimental stations, so that here we have apparently an example of the inheritance of acquired characters.

Pines (*P. vulgaris*) two to six years old, grown from seeds produced by trees which in turn had been grown from seeds collected 30 to 40 years ago at low elevations and planted at high altitudes, were distinct from the normal lowland pines of this species only in the smaller proportion of large individuals. The parent trees had presreved in the new climate the habit of growth of their original habitat and had transmitted it to their progeny. In this case "after effect" had become "heredity."

EUGENICS IN THE COLLEGES

CORNELL UNIVERSITY is organizing a course in Genetics and Eugenics to be given in the early part of 1914 by a number of specialists.

There are now 44 colleges giving either a complete course in eugenics or some lectures on it as part of another allied course; 15 in the East, 14 in the Middle West, four in the South. Sixteen teach eugenics in their zoology department, 11 in the biology department and 11 in the sociology department.

The following is a partial list of courses in eugenics (often combined with genetics) given in the colleges of the United States last year.

Agricultural College of Utah	Zoology Department.
Alfred University	Biology Department.
Barnard College	Zoology Department.
Bryn Mawr College	Biology Department.
Carnegie Institute of Technology (Margaret Morrison Carnegie School).	Department of Science.
Central University of Kentucky	Biology Department.
Colorado Agricultural College	Entomology and Zoology Department.
Cornell University	Plant Breeding Department.
Dakota Wesleyan University	Biology Department.
Dartmouth College	Sociology Department.
Denison University	
Elmira College	Sociology Department.
Harvard University	Zoology and Psychology Departments.
Knox College	Biology Department.
Marietta College	Biology Department.
Massachusetts Institute of Technology	Biology Department.
Middlebury College	Zoology Department.
Oberlin College (Summer Session)	Sociology Department.
New York University	Sociology Department.
State College of Washington (Series of Lectures).	
Syracuse University	Zoology Department.
Rush Medical College (University of Chicago)	Zoology Department.
Tulane University	
University of California	Zoology Department.
University of Chicago	Department of Political Economy and Zoology Department.
University of Colorado	Biology Department.
University of Florida	Sociology Department.
University of Illinois	Zoology Department.
University of Minnesota	Animal Biology Department.
University of Nebraska	Sociology Department.
University of New Mexico	Biology Department.
University of North Dakota	Sociology Department.
University of Oklahoma	Zoology Department.
University of Pennsylvania	Sociology Department.
University of Pittsburgh	Department of Biology, Sociology and School of Education.
University of South Carolina	
University of Southern California	Sociology Department.
University of South Dakota	Human Economics.
University of Tennessee	Zoology Department.
University of Texas	Zoology Department.
University of Washington	Department of Political and Social Science and Department of Zoology.
Washington University Medical School.	
Western College	Biology Department.
Western Reserve University	Sociology Department.

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CONTENTS

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Date of issue of this number, April 25, 1914.

"THE BASIC STOCK OF ALL HUMANITY"?

Negritos of the Phillipine Islands. Dr. Bean thinks they are a fusion of the three fundamental races of mankind, the Australoid, Iberian and Primitive, the former predominating. This Australoid stock, he suggests, may be the original one from which the other two are derived, unless it is itself a result of the fusion of the Iberian and Primitive somewhere in eastern Asia in prehistoric times. The Australoid stock is that which is chiefly responsible for the American negro. (Frontispiece.)
(See "The Phillipine Negritos," page 216.)

CROSSING BISON AND CATTLE

First Cross Dangerous But Results are Better in Each Succeeding Generation—Hope of Taking Fur and Hump of Bison and Placing Them Upon Back of Domestic Ox.

Mossom M. Boyd, *Bobcaygeon, Ontario, Canada.*

WHEN in 1908 I gave an account[1] of my firm's (Mossom Boyd Co.) experiment up to that date in crossing the American bison with domestic cattle, we had just begun the third stage of the experiment; and although four years[2] in a work of this kind is too short a time in which to accumulate much data of interest, I will nevertheless report what little there is to tell.

The first stage of the experiment was the crossing of the two species.

The second consisted of crossing the hybrids thus produced with pure-bred animals of both species.

And the third stage, in which we are now engaged, consists of breeding from parents, both of which are of mixed blood.

The produce of the first stage in which both parents were pure, we call hybrid buffaloes or half-bred-buffaloes, or for short, hybrids. The produce of the second stage in which one parent was pure and the other of mixed blood we call three-quarter-buffaloes, or one-quarter-buffaloes, or one-eighth-buffaloes, as the case may be, reserving for the sake of distinction the term "cattalo" for the produce of the third stage in which both parents are of mixed blood; and we put before the word cattalo a figure to denote the proportion of bison blood; for example, one-half cattalo (containing 50% of bison blood), one-quarter cattalo (containing 25%), and so on. Breeders will readily understand that there is a radical difference between what we now call cattaloes and three-quarter, one-half, one-quarter and one-eighth-buffaloes. Excepting two or three, we have not been raising animals carrying less than one-eighth of buffalo blood.

CHARACTERS OF THE HYBRIDS.

In the first stage the hybrids, of which we succeeded in raising about 30, were all of one type; so uniformly alike that individuals of the same color were as hard to distinguish from one another as are Polled Angus cattle. Those from Hereford dams had white faces, but almost no other white; and excepting these, all were practically whole-colored, and were either brindled or black. The black was not the jet black of the Polled Angus but had a rich tinge of brown. The brindled varied between a tawny red and brown.

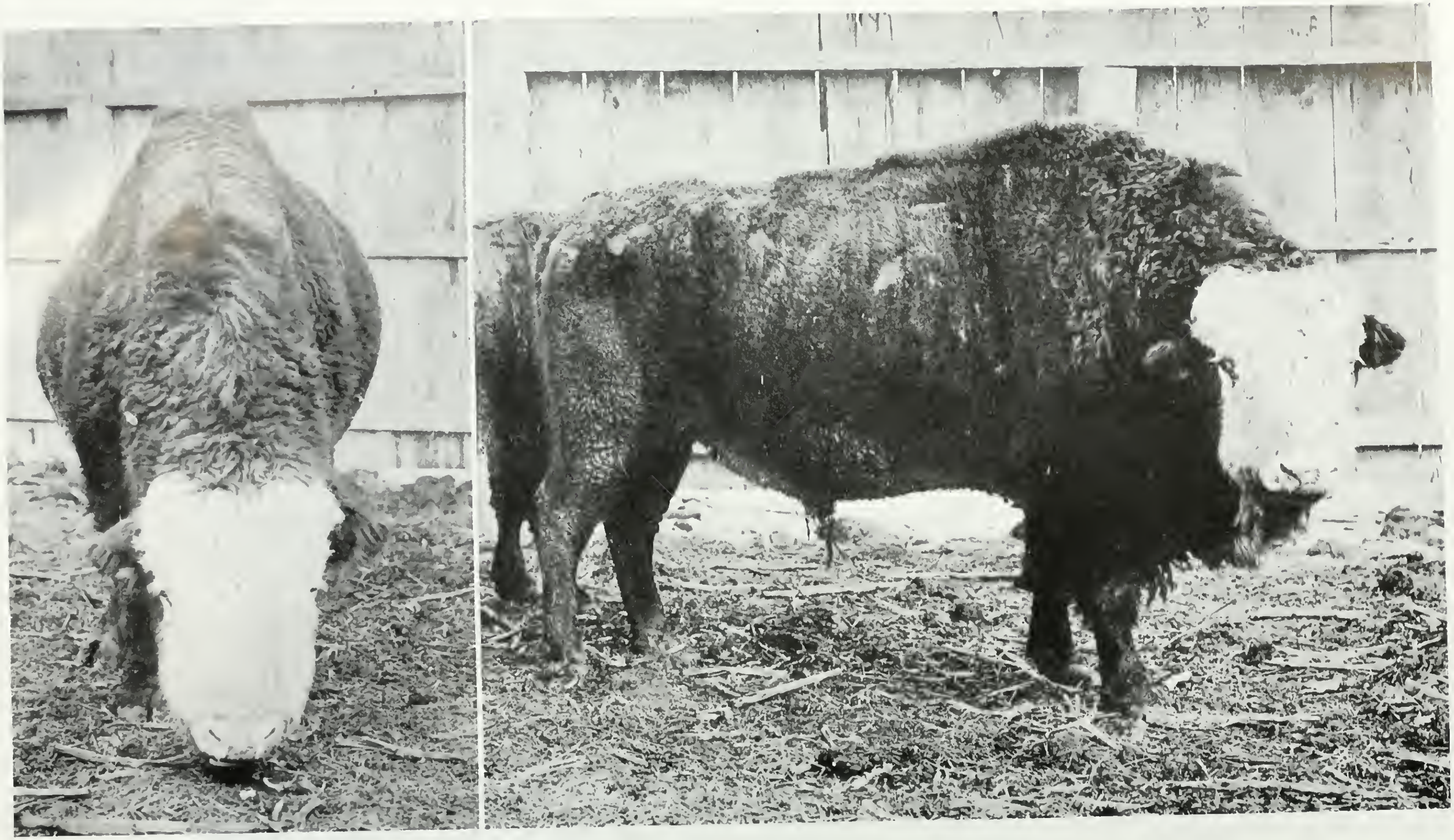
The hybrids were larger than the bison; of "smoother" build; wider chested, had better hind quarters, stood straighter on their hocks, and had coats of a better color, with more lustre and less tufted. Altogether they were much finer-looking animals than the bison.

The three-quarter-buffaloes, got by using a bison bull on the hybrid females, were likewise all of one type; as much like one another as are Polled Angus cattle; and they were about midway in appearance between their parents. The five we raised (one bull and four females) were in color very much like the bison, but of a somewhat darker shade. One, whose dam was half-Hereford, had the front of its face white.

The one-quarter-buffaloes, got by using Polled Angus and Hereford bulls on the hybrid females, were all of one

[1]A Short Account of an Experiment in Crossing the American Bison with Domestic Cattle, by Mossom M. Boyd. American Breeders' Association Annual Report, vol. IV, p. 324 ff.

[2]This paper was prepared in January, 1913. Mr. Boyd writes that at present his company has 31 head of grade buffaloes and cattaloes in its herd.



"QUINTO PORTO": FIVE-EIGHTHS BUFFALO AND THREE-EIGHTHS HEREFORD.

This striking result of hybridization of the American bison is out of a one-quarter-buffalo, three-quarter Hereford cow, by a pure buffalo bull. His exact pedigree is given in the text. This cross was particularly interesting, Mr. Boyd remarks, because it represented the nearest approach to a repetition of the dangerously severe first cross, when a pure Hereford cow was bred to a pure buffalo bull. Male calves are rarely, if ever, born from such a cross, but this example shows that the presence of one-fourth buffalo blood in the cow is sufficient to insure the possibility of producing a fertile bull calf. (Figure 1.)

A "HEREFORD" WHO IS FIVE-SIXTEENTHS BUFFALO.

"Huron," son of "Quinto Porto" (shown on preceding page), out of a pure Hereford cow. It is from such crosses as these or one generation further removed (say 10% to 15% buffalo blood) that it is hoped to improve the range cattle of the colder parts of the west, increasing their hardiness and improving their meat-producing and fur-producing qualities. (Figure 2.)

type in form, but varied in color, and likewise were about midway in appearance between *their* parents. The same remarks apply to the one-eighth-buffaloes, got from a second cross by the same breeds of domestic bulls.

An ordinary observer might mistake the three-quarter-buffaloes for bison; and he would scarcely distinguish the one-quarter-buffaloes from domestic cattle, except for the finer quality of hair. The one-eighth-buffaloes he would not distinguish at all from domestic cattle.

Accordingly, in stage one we got animals that were all of one type. In stage two, animals that were all of one type or all of another, according as we used the bison bull or the domestic bull; and the proportion of bison blood always determined the measure of likeness to the bison.

In stage three, as was expected, the proportion of bison blood no longer determines the likeness to the bison. We have two one-half-cattaloes, yearlings, quite as like the bison as are our three-quarter buffaloes; and among 12 cattalo calves of 1912 are a one-half-cattalo, a three-eighths-cattalo and a one-quarter-cattalo, which, notwithstanding their difference in grade with respect to bison blood, show equally the

A FIRST-GENERATION HYBRID.

This cow represents the most difficult achievement of hybridizing buffaloes—namely, the first cross, between a pure buffalo bull and an ordinary cow. (The reverse cross cannot be made.) The percentage of failures in this cross is extremely high, and almost no male calves are produced, partly, at least, because their height just back of the shoulders prevents them from passing through the cow's pelvis. Hybrid cows of the sort shown in the photograph are often barren, but fertility is gained at each subsequent cross back to cattle blood. (Figure 3.)

HEIFER WITH HALF BUFFALO BLOOD.

The hybrids average rather larger in size than either parents (buffalo cows weighing only 1,000 to 1,200 lbs., while the buffalo bulls weigh from 1,800 to 2,000). Their meat is said to be indistinguishable from beef of the same age and quality, but they produce more of it, and the cuts are considered choicer. The first hybrids of this sort were produced as far back as the revolutionary period; in 1908 W. T. Hornaday estimated that there were 260 of them in the United States, 57 in Canada and 28 in Europe, a total of 345, while the number of pure bison in the world at that time barely exceeded 2,000 (Figure 4.)

bison characteristics. The one-quarter-cattalo has, we think, somewhat the best coat of the three.

HOPE FOR THE FUTURE.

This is encouraging, especially in these early matings, and seems to warrant the expectation that in later generations, after there has been time for selection, there may be seen on cattaloes, having say 10% or less of bison blood, as good fur as is now seen on the one-half and three-quarter-buffaloes.

Moreover, there is a promising prospect of greatly improving the beef carcass also, for the bison carries an exceedingly high percentage of beef on his back, which is the most valuable part of a beef carcass; and the inheritance of this quality may well be encouraged by selection. The hump of the buffalo is not a mass of fat as some people suppose, but is formed by neural spines in length fully double those of domestic cattle, and by the huge muscles which lie alongside and fill up the angle between these neural spines and the ribs. In a rib roast of beef, these muscles constitute the upper cut, and I have had on my table a hybrid roast with an upper cut nine inches deep.

I give the measurements of the length (measured from the centre of the spinal cord) of the neural spines of the smallest of our three bison bulls. They are in inches respectively: 11, 16½, 16½, 16, 15½, 14¼, 13, —, 10½, 9½, 8, — , 6¾, — , 4¾, — .

THREE-QUARTERS-BUFFALO BULLS.

Bulls of this type are larger and "smoother" in build than the average full-blood bison bull; they are wider between the front legs and thicker between the quarters, and stand straighter on their hocks. Frequently they are not fertile, or only imperfectly so. In the hands of the butcher they will cut about 70% net of their gross weight, according to Col. Goodnight. The bull here shown was bred by the Mossom Boyd Co., and is by a pure buffalo out of a hybrid (first generation) cow. (Figure 5.)

DANGERS OF FIRST CROSS.

The most remarkable and the most disastrous feature of the first stage was the abnormal secretion of the amniotic fluid which was excited without exception in every cow and which proved fatal in a large percentage of cases. This feature was so calamitous that others should be warned against attempting this severe cross. We began without any suspicion of the evil and had we not gone to work unwittingly on a large scale, the experiment would probably have failed in the first stage.

Fortunately no trouble of this sort was experienced in the second stage and none to date in the third stage; but we had an interesting reminder of it through crossing our five-eighths-buffalo bull on three domestic cows in 1911. One of these cows swelled to proportions which indicated the former trouble, but it did not prove serious and it is possible that the diagnosis was wrong. The other two cows did not attract any notice in this respect.

FERTILITY OF BULLS.

On the subject of fertility or infertility of bulls I have not much data. The percentage of male births in the first stage was so small as to be remarkable and excite curiosity as to a possible cause. Out of forty-five hybrids only six were male, i.e., about 15%, and we may add to this experience that of Charles Goodnight, who wrote me in 1900 that he had raised many female hybrids but had never one male born alive. Of our six, three died at birth, one within 24 hours, and of the two raised one proved barren after having been thoroughly tested. The other was killed at an early age without having been tested.

In the second stage the proportion of male births rose to 40%. Out of 26 one-quarter-buffaloes, ten were males.

Of these only four were tested and one of the four was found normally fertile. The other three were barren up to 36 months, 32 months, and 25 months of age, respectively, but should have had a longer trial.

Of five three-quarter-buffaloes one only was a bull and this bull, born in March, 1905, was killed by an accident in September, 1908, i.e., at the age of three and one half years. Although given a fair opportunity during the seasons 1907 and 1908 he did not appear to be fertile, but should have been further tested.

Of one-eighth-buffaloes, the only one tried was thoroughly fertile.

One five-eighths-buffalo bull was bred in 1905 from the cross of a bison bull upon a one-quarter-buffalo cow. This cross was interesting as being our nearest approach to a repetition of the severe cross of the first stage. It proved that the 25% of bison blood in the cow was sufficient to make the cross perfectly successful; for gestation was normal and the bull is more or less fertile. We had one calf by him in 1911 and four in 1912. His pedigree is interesting and I give it here:

QUINTO PORTO

Brindle with white face	Born May 23, 1905
dam Quarto Prettymaid	Sire Banff 2nd (a pure Bison)
g. d. Hybrid Prettymaid	by Tecumseh 63518 Am. Hereford Record
3 d. Prettymaid 19th 55397 Am. Hereford Record	by Bonie (a pure Bison)
	by Cherub 4th 32333 Am. Hereford Record

It will be seen that he is a mixture of pure buffalo and pure Hereford blood. He is a whole-colored brindle except for the white front to his face; and like the hybrids he is larger and "smoother" in build than an average bison bull; is wider between the front legs and thicker through the quarters; stands straighter on his hocks, and has an immense back.

We have a yearling bull by "Quinto Porto" out of a registered Hereford cow.

FERTILITY OF COWS.

Of 24 hybrid cows, 15 were barren and of the remaining nine only three were regular breeders. These three, all born in 1895, are now 18 years old, and were regular breeders up to last year; having to their credit nine, ten and twelve calves respectively.

Of 12 one-quarter-buffalo cows got by using domestic bulls on the fertile hybrids only one was barren, four were irregular breeders, and seven normally prolific.

Of four three-quarter-buffalo cows got by using a bison bull on the hybrid females only one proved barren, and this one was by a sire which was himself a very poor breeder, for he got no other produce although he had the run of the herd for four months.

The tables on page 197 are given for comparison with the table for the hybrids given in my former report.

The average age at which the *hybrids* produced their first calf was four years.

Of five one-eighth-buffalo cows, one was beefed at four and one-half years of age without having bred, and four were found normally fertile.

As to the fertility or infertility of cattalo bulls we have no information at all. Of 73 cattalo births to date, 30 were bulls. Six of these are being kept for testing but no testing has been done yet. The first females have just come to the breeding age. Of two born in 1907, one gave a calf in 1911 and the other was sent to the butcher December, 1912, as being probably barren. Of four born in 1908, only one has given a calf as yet. We have besides a calf from a three-year-old, and one from a two-year-old. This is sufficient to indicate that even if not so much so as the grade buffaloes (hybrids excepted) which were just about normal, the cattalo females will be fairly fertile; and there is little doubt as to finding a sufficiency of fertile bulls. Complete fertility, if it is not found at once, will doubtless come through selection, as will early maturity.

It does not seem unreasonable, therefore, to suggest that the fur of the bison and his great back may be carried by

A TRUE CATTALO CALF AND ITS MOTHER.

The sire was a grade buffalo (exact pedigree unknown), while the mother is three-quarters buffalo from a first-generation hybrid cow by a pure buffalo bull. This heifer having mixed blood in both lines of ancestry, is therefore a true "cattalo." The photograph, like all those preceding, was made on the ranch of the Mossom Boyd Co., in Ontario. (Figure 6.)

means of selection without any diminution through succeeding generations of diminishing bison blood until the coat and hump have been practically taken from the bison and placed upon the back of the domestic ox.

BREEDING RECORD OF ONE-QUARTER BUFFALO COWS, DECEMBER 31, 1912.

Cow Born	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	Age of dam when she produced her first calf. Yrs.	Months
July 1899	B	....	C	beefed Dec. 1905								2	9
Aug. 1899	....	beefed Dec. 1903											
Apr. 1900	C	B	B	....	C	C	....	C	C	C	....	2	3
June 1900	....	....	B	....	....	beefed Dec. 1907						3	6
Mar. 1901	....	B	....	B	....	C	C	B	B	B	C	2	2
Apr. 1901	....	C	....	C	B	B	A	B	....	C	....	2	1
May 1901	....	C	....	....	beefed Jan. 1906							2	
Mar. 1902	....	....	C	....	C	B	C	beefed Dec. 1911				2	2
Apr. 1902	....	....	....	....	C	....	B	B	B	C	....	4	4
May 1904	....	....	....	....	....	....	A	beefed Dec. 1908					
June 1906	....	....	....	....	....	....	C	....	B	C	B	2	2
June 1906	....	....	....	....	....	....	B	beefed Dec. 1911				2	
												2	6½

B—Bull calf. C—Cow calf. A—Abortion.

The double line divides the grade buffalo calves from cattalo calves.

BREEDING RECORD OF THREE-QUARTER-BUFFALO COWS, DECEMBER 31, 1912.

Cow Born	1909	1910	1911	1912		Age of dam when she produced her first calf. Yrs.	Months
Apr. 1903	....	....	....	....	Barren	....	....
Mar. 1905	....	A	C	....		5	....
Mar. 1905	....	....	....	B		7	....
May 1905	......	C	....	....		4	11
						5	8

MY EXPERIENCE WITH BISON HYBRIDS.

CHARLES GOODNIGHT, *Goodnight, Texas.*[3]

I CAN summarize my experience in crossing Texas buffaloes with native cattle, as follows:

I take a male buffalo calf, put him with a native cow and let him suck her until weaning time. I let him run with common cattle until large enough to serve. He will then cross with any kind of domestic cattle. In making the first cross, no male calves have ever been born; cows conceiving them either suffer abortion or die, hence I only get heifer calves and a small per cent. of them. There is no trouble

[3]See also "Breeding Cattelo" by C. J. Jones, in American Breeders' Association Annual Report, vol. III, p. 161, 1907.

CATTALOES ON THE RANGE AT THE GOODNIGHT RANCH IN TEXAS.

Col. Charles Goodnight began to domesticate bison in 1880, and produced his first hybrids in 1885. C. J. ("Buffalo") Jones began in 1885 by purchasing hybrid calves in Manitoba; both men are still engaged in the work, which hitherto has proved so costly and unsatisfactory as to lead William T. Hornaday to say in 1904, "It is now quite time that all such experiments should cease. It has been proven conclusively that it is impossible to introduce and maintain a tangible strain of buffalo blood into the mass of western range cattle." (Am. Nat. Hist., p. 103.) Since then, further progress has been made and there now seems to be more hope than ever of a successful outcome of this experiment in hybridization, which has been in progress for at least 125 years without having produced results on a commercial scale as yet. (Figure 7.)

whatever in giving birth. The cause of abortion and death is unknown to me. The heifer calves obtained breed readily to either the buffalo or the cattle. When bred to the buffalo, the males, which are three-quarters, are not fertile. The females are perfectly fertile and will breed to either race. I breed them back to the polled Angus stock from which they come, and get males which are fertile and which are half-breeds.

The type or race of hybrid cattle is now virtually established in a small way and I herewith give you a few of the points of advantage which the "cattelow"[4] have over common cattle.

First, they are immune from all diseases as far as I have tested them. I know they are immune from Texas Black-Leg and Texas Fever. I have shipped three bulls, one-eighth buffalo, to our coast, the worst tick-country we have. One died and two are living, so I have reason to believe that if they were a little higher in the buffalo blood, they would be entirely immune.

Second, the "cattelow" are much greater in weight, eat much less and hold their flesh better under more adverse conditions. They will easily cut about 70% net of their gross weight. They have a better meat, clear of fibre, and it never gets tough like beef.

They have long and deep backs, enabling them to cut at least 150 pounds more meat than other cattle. More of them can be grazed on a given area. They do not run from Heel Flies nor drift in storms, but like the buffalo, face the blizzards. They rise on their fore feet instead of their hind feet. This enables them to rise when in a weakened condition. They never lie down with their backs down hill, so they are able to rise quickly and easily. This habit is reversed in cattle.

When a herd on range gets weak and poor towards spring, their lying down with their backs towards slopes and on sides of hills causes a loss of from 1% to 6%. Every weak cow which so lies down can never get up, unless she is found by the herder.

The buffaloes have 14 ribs, giving them a longer and deeper loin. As we get them higher and deeper in the buffalo we get the extra rib on the "cattelow." They can exist on less food or salt than cattle, as before stated.

They could do without water much longer than cattle, without inconvenience. They are docile, easily broken and never fight. They put on flesh faster than any cattle and will live and appear to do well where cattle will perish. They have many other points in their favor too tedious to mention.

Genetics Must Come First

In studying the inheritance of the more simple physical characters in man, it is evident that we are as yet only feeling our way toward the solution of certain larger and more complicated problems which are of vital importance to the human race. The future of eugenics depends very largely on the solution of these problems. I do not wish for one moment to suggest that the art of eugenics has been born before its time, but I do feel that before we can venture to apply the scientific principles of genetics to human life, we must first make our foundations sure. For this reason, I am convinced that a good deal of spade work in human genetics will have to be done before any considerable amount of practical good can be accomplished in eugenics. Eugenics is simply applied genetics, and *sound eugenics can only be founded upon sound genetics.*—C. C. Hurst: Mendelian Heredity in Man (1912).

[4]The word is so written in Col. Goodnight's manuscript. The spelling "cattalo" has now been generally accepted, after some years of confusion, and is adopted by practically every authority. It is the preferred spelling of this Association.—The Editor.

AN APPLE CHIMERA

Two Varieties Combined in One as Result of Grafting—Fruit Does Not Seem to Fall Wholly in Either of General Divisions of Chimeras—An Explanation of the Phenomenon.

W. E. Castle,

Bussey Institution, Harvard University, Forest Hills, Mass.

About five years ago, S. A. Starratt casually mentioned to me having seen in Nova Scotia apples which individually consisted of two very distinct varieties of apple separated by a sharp line of demarcation. The statement interested me much as I recalled Darwin's description of such fruits and his uncertainty as to whether they were to be regarded as graft-hybrids or eversporting seedling hybrids. Upon my expressing this interest Mr. Starratt kindly volunteered to secure me fuller information about the peculiar apple tree. As a result I received in the spring of 1909 from W. W. Clarke of Bear River, Nova Scotia, a letter, from which I quote below, together with a package of scions cut from the freak apple tree (or rather trees, for Mr. Clarke's letter indicated that there were several of them and of two different sorts). Some of the scions I was able to graft successfully upon trees in my orchard, but they have not yet borne fruit. In the letter already mentioned, Mr Clarke says:

"About a month ago S. A. Starratt, Esq., wrote me concerning some apples of a peculiar growth I showed him a few years ago. The peculiarity was. that of the apples grown upon the same stem, portions, perhaps, would indicate different varieties. For instance, one end of the apple would have all the characteristics of the Boston Stripe; the other end would be Russet; and where the joining took place there generally was a small ridge, seemingly, because one variety was larger than the other, and that Nature was doing her best to make a good job of a misfit. I did not grow the apples myself, but do know different trees in the orchard, say ten or a dozen, produced the kind of apple referred to. The man who grows these apples says the parent tree was grown from seed and grafted with Boston Stripe, except one tree which was grafted with Greenings, but grown from seed. Mr. Starratt wished me to send you some scions, which I have done today by one of our schooners that is due to arrive in Boston about the 24th to 26th inst. I have instructed the Captain to express direct to you immediately he arrives.

"The scions are in one package but separately tied; the ones marked Greenings are off the limb that produced the hybrid apples last autumn, the Boston Stripe are off the trees that produced the freak apples, but cannot say if the same limbs. No one tree produces any great quantity of the apples referred to, perhaps two or three dozen on the whole tree, the balance will be Boston Stripe or Greening pure and simple. I will undertake to send you some of these apples this autumn when grown."

Apparently Mr. Clarke was unable to secure any of the peculiar apples in the fall of 1909, but two years later, in November, 1911, I was pleased to receive a package containing half a dozen of them, three of which are shown in the photograph kindly made for me by E. W. Nelson. With the apples came a letter as follows:

PARENTAGE OF THE FREAKS.

"I am mailing you today a sample of the Freak Apples. I understand the parent stock was what is known as Boston Stripe into which was grafted Golden Russet. You have the result.

A PLANT-CHIMERA: TWO VARIETIES OF APPLE IN ONE.

Golden Russet and Boston Stripe combined in the same fruit, as the result of a graft. Trees producing these apples bear only a few fruits of this composition; the rest of the crop belongs entirely to one or other of the two varieties concerned. The explanation of these chimeras is that the original buds of the scion failed to grow, after the graft was made, but an adventitious bud arose exactly at the juncture of stock and scion, and included cells derived from both. These cells grow side by side but remain quite distinct in the same stem, each kind of cell reproducing its own sort. (Figure 8.)

I notice these all show the G. Russet at the stem end. I have seen the blossom end Russet. I may say the whole tree does not produce all like the sample, since the Russet predominates. The fruit is not as large as it should be, for the trees lack the necessary culture."

The account given in this letter does not agree altogether with that given in Mr. Clarke's earlier letter, as to the parent varieties. The earlier account stated that Boston Stripe grafted on a seedling gave rise to the parent tree; in this account Boston Stripe is the stock and Golden Russet the scion. It is impossible at present to decide between the two accounts. The photograph shows very well the sharply marked division of the apples into regions very different in appearance. The stem end of the apple was in each case of "russet" and without stripes; the blossom end was smooth skinned, of a light red color striped with yellow or green (uncolored). When one of the apples was cut open the flesh was found to be different in texture and flavor in the two regions. Underneath the russet skin the flesh was coarser grained. One end of the apple was distinctly sour, the other insipid, almost sweet, but I neglected to note *which* region was sour, the russet or the striped portion, but I think the former. The line of demarcation within the flesh was sharp, as on the surface.

Since the time when these "freak" apples first came to my attention the nature and origin of such plant creations has been investigated with brilliant success by Winkler and Baur in Germany. As a result we now call such things *plant-chimeras*, and we know that they arise in consequence of grafting, in cases wherein the original buds of the scion have failed to grow, but an adventitious bud has arisen exactly at the junction of stock and scion and including cells derived from both. Each of these two kinds of cells reproduces its own sort, though they remain side by side but quite distinct in the same stem.

Winkler has produced several different sorts of chimeras by grafting the tomato (Solanum lycopersicum) and the nightshade (S. nigrum) one upon the other and then decapitating the graft. In some of these the stem is divided right and left between tomato and nightshade tissue, the stem on one side bearing tomato leaves, on the other nightshade leaves. Such plants are known as *sectorial* chimeras. In other cases, tomato cells form the one or two outer layers of the entire plant, while underneath occur only nightshade cells; or these relations may be exactly reversed. Histological study fully confirms this view. Such chimeras are known as *periclinal*.

In the apples figured the chimera would seem to be sectorial rather than periclinal, if the line of demarcation ran lengthwise of the apple rather than across it. But as it is, they resemble more a periclinal chimera which has everted its deeper lying tissue at the blossom end of the fruit. Does the fruit of the apple develop in that way? Will such fruits give us a clue to the answer? They certainly merit further study.

Galton's Law of Regression

The law of regression tells heavily against the full hereditary transmission of any gift. Only a few out of many children would be likely to differ from mediocrity as widely as their mid-parent, and still fewer would differ as widely as the more exceptional of the two parents. The more bountifully the parent is gifted by nature, the more rare will be his good fortune if he begets a son as richly endowed as himself, and still more so if he has a son who is endowed yet more largely. But the law is even handed; it levels an equal succession tax on the transmission of badness as of goodness. If it discourages the extravagant hopes of a gifted parent that his children will inherit all his powers, it no less discountenances extravagant fears that they will inherit all his weakness and disease.—Francis Galton: Natural Inheritance (1889).

SEXUAL INEQUALITY IN HEMP

Male Plants Die While Females Grow Vigorously Under Same Conditions—Possible Sex-Limited Environmental Character Suggested—Advantage to Females of Death of Males—Reversal of Usual Effects of Selection.

O. F. Cook,

Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

A STRIKING example of sexual inequality was noticed in August, 1912, in a plot of hemp that was being grown on the Virginia Truck Experiment Station, near Norfolk. The nature of the inequality will be apparent by reference to figures 9 and 10. All of the male plants were very slender and spindling, and the foliage was of a pale yellowish green color, in strong contrast with the deep blackish green of the female plants. In addition to their more robust form, the female plants were often a foot taller than adjacent males, the largest of the female plants attaining about three feet. Many of the male plants had already died at the time the photographs were taken, August 13, and the others were evidently to follow shortly. But all of the female plants were still fresh and vigorous, and were growing and flowering under conditions that were bringing the male plants to an early death.

To describe the female plants as stronger and more resistant than the male plants seems a rather inadequate statement of so great an inequality of behavior. If two species were tested and were found to react so differently we would say that one of them was adapted to the conditions, and that some essential character was lacking in the other. With two sexes of the same plant behaving so differently, the idea of a sex-limited environmental character is suggested. Certainly there is no general reason or analogy for believing that sex alone would explain so great a difference of behavior under the same conditions.

In the perennial plants that have the sexes represented by separate individuals, as among the dates, figs, carobs, poplars, rubber trees, etc., the male individuals appear to have greater vigor and longevity than the females. No doubt it would be an advantage in an annual plant like the hemp to have the males die out after they have shed their pollen. The early death of the males means less competition with the adjacent female plants while these are engaged in maturing seed. The more unfavorable the conditions the more desirable that the males die early in order to increase the chances that the seed be matured. But the advantage of having the males die earlier would not of itself cause them to die. Some other specialization or intensification of the sexual differences must have arisen. On account of the factor of competition between the sexes the usual effects of selection would be reversed. Under extreme conditions short-lived male plants would be likely to leave larger progenies than long-lived males, for the female plants that stood next to short-lived males would be able to ripen more seed. The natural result of such variation and selection would be the development of a plant with short-lived, ephemeral males corresponding to drone bees and similar specializations of the sexes among insects and other invertebrate animals.

WHY THE PLANTS DIE.

It would be interesting to determine the extent to which the presence or the competition of the female plants may be responsible for the early death of the male plants. This could be learned by

FEMALE AND MALE HEMP PLANTS.

The three females (at the left) are growing vigorously, while the three males (at the right), under identical conditions, are dying or already dead. The difference in behavior is so extreme that Mr. Cook suggests a possible sex-limited environmental character to account for it, since it seems improbable that sex alone would explain so great a difference of behavior under the same conditions. (Figure 9.)

SEXUAL INEQUALITY IN A FIELD OF HEMP.

Plants of a Chinese form of hemp, grown at Norfolk, Virginia, and photographed in August, 1912. All of the leafy plants that are readily seen are females, the very slender, thread-like stems representing the males. It seems to be an advantage to the species (this being an annual) to have the males die as soon as they have yielded their pollen, for their competition is thus removed and the females given a better chance to produce seed. Mr. Cook suggests that a reversal of the usual effects of selection would develop a race of plants with short-lived, ephemeral males corresponding to drone bees. (Figure 10.)

raising some of the male plants in plots by themselves. If male plants were found to live longer alone than with the female plants, it might be inferred that they are starved or strangled by the female plants, just as the dwarf male spiders are often killed and eaten by their huge and hungry mates. In both cases the death of the males contributes incidentally to the welfare of the progeny, whereas their continued existence would not.

OTHER VARIETIES LESS UNEQUAL

In the ordinary varieties of hemp grown for fibre or drug purposes there is no such striking inequality of the sexes. Though the male plants die somewhat in advance of the females, they attain nearly the same stature and live through most of the season. The variety that shows this extreme inequality of the sexes is recognized by L. H. Dewey as the so-called Russian or Manchurian hemp, which is extensively grown in Europe and Asia, not for the fibre, but for seed. The oil extracted from the seed is used for food and also has rapid-drying qualities that render it of interest to manufacturers of paint and varnish. The plant has not been grown on a commercial scale in the United States, but attention is now being given to this possibility. The seed crop is much larger than with the varieties grown for fibre, for which the earlier mortality of the males may be partly responsible. Indeed, if the sexes had an equal development it would be hard to believe that a dioecious plant could compete with a bisexual species in seed production. This may be a reason why there are relatively few dioecious plants among annuals.

With perennial plants there could be no corresponding advantage in having the males short-lived. The existence of perennials is not so acutely dependent upon the production of seed every year as upon the ability to gain and hold ground against the competition of other species. In this struggle, large, long-lived male plants doubtless have advantages that more than counterbalance the factor of competition between the sexes. But even with perennials the general tendency of selection is probably in favor of the bisexual types and against the separation of the sexes in different individuals.

SHORTENING OF INTERNODES.

Another peculiarity of the oil-seed hemp is that the lateral fruit-bearing branches have extremely short internodes, analogous to those of the so-called cluster varieties of cotton. The shortening of the fruiting branches may also be connected with the earliness and productiveness of the crop, from which high yields of seed are obtained. This form of hemp, according to Mr. Dewey, is probably the same as that described by Pallas as *Cannabis erratica*, though it is not usually considered as a species distinct from the ordinary *Cannabis sativa*. It has probably been cultivated in China since a very remote period. References to the sexual diversification of the hemp plant in Chinese literature are dated as far back as 2700 B. C.

NOTE.—The Editor has called my attention to a paper that is to be published in the same issue of the Journal, in which a theory of sex-determination appears to have been based largely on experiments with hemp. The inequality of the sexes naturally suggests the question whether the results ascribed to sex determination might not be due to other causes, such as unequal susceptibility of the seedlings to adverse environmental conditions.

Lectures Are In Demand

Announcement in a recent issue of the JOURNAL OF HEREDITY that a lecturer was now available for talks on eugenics, has led to a gratifying demand for the services of A. Edward Hamilton, of the Eugenics Record Office, Cold Spring Harbor, Long Island, New York. He can be secured by clubs, colleges and other organizations which wish to give serious attention to eugenics; his services are made available through the liberality of Mrs. Huntington Wilson, of this association.

THE DETERMINATION OF SEX

Botanist of Lemburg Professes to Have Found That Age of Pollen at the Time of Fertilization is Determining Factor—Claims High Percentages in Experiments—Has Tested Discovery in Animals and Man, He Says.

P. J. Wester,

Horticulturist in Charge of Lamao Experiment Station, Philippine Bureau of Agriculture.

THE determination of sex is a riddle that for ages has puzzled the minds of men and numerous are the theories that have been advanced in an attempt to explain which factors determine the sex in the progeny—theories advanced only to be abandoned as untenable in the light of further experimentation. It has long seemed and by many been asserted that sex determination was a mystery held in trust by Nature that was forever to remain unravelled[1]. It now appears that while it has continued to occupy the minds of many scientists, the problem may in reality have been solved for some years. This remarkable discovery, which unquestionably will mark a new epoch in animal breeding no less than in the eugenics of the human race, if the apparently simple law involved is upheld by thorough tests and becomes generally diffused, was made in 1878 by Prof. Theophilus Ciesielski in Lemburg as a result of continued experimentation begun in 1871.

The earliest investigation by Ciesielski was conducted on Indian hemp (*Cannabis sativa*) and garden spinach (*Spinacia oleracea.*) It is not here necessary to go into detail regarding the earlier years of experimentation which yielded negative results to the investigator. In a paper published first in Latin and later translated into English, in which form it appeared in International Clinics, Vol. 3, 22nd series, 1912, prefaced by a review by Dr. S. W. Carruthers, of Norwood, England, Ciesielski thus relates the circumstances under which the discovery of the law of sex determination was made:

"As soon, then (1876), as the sex of the plants *Cannabis sativa* . . . could be determined I took out all male plants from the . . . garden, leaving only female ones, . . . Thereafter, as soon as the female plants were mature I fertilized them with pollen from the male plants . . . simply by shaking the male plants over them. The female plants in the upper garden I fertilized daily at sunrise, but those in the lower garden just before sunset.

HIGH PERCENTAGE SECURED.

"The seed collected from those divisions I sowed again in 1877, separately in the upper and lower portions of the garden, but in new plots, to avoid any possible fallacy from seeds of the former experiment casually and spontaneously shed in the old plots. The result was that from seed derived from plants fertilized at sunrise I obtained 85.5% of male plants, while the seeds

[1]For the benefit of readers who are not in touch with recent biological researches, it should be said that many of the investigators who have given the most study to the question believe the determination of sex depends on the inheritance of a Mendelian factor differentiating the sexes. Microscopical studies of the cell indicate that the presence of an accessory or "x" chromosome in the sperm or egg (usually the latter) is the deciding factor, in some species. If sex does Mendelize, the proportion of males and females is thus subject to the laws of chance—in other words, an equal number of each will be produced, if the quantities involved are large enough to furnish accurate statistical results, and if differential mortality does not take place.—The Editor.

gathered from plants fertilized at sunset produced 92% of female plants.

"In view of the success of these experiments in fertilization I took up, in 1877, six female plants with their roots, before they had fully produced their flowers, and transplanted them into pots; as soon as the plants were well rooted I transferred the pots to the windows of two rooms looking south, three pots in each room. Thereafter, with a brush, I fertilized the three plants in one room with pollen which I collected from anthers just dehiscing and not yet fully open (this pollen I shall refer to as fresh), and the three pots in the other room I also fertilized by means of a brush, but with pollen taken in the morning and kept in paper till evening. The three plants fertilized with 'fresh' pollen produced 120 seeds; the three fertilized with 'stale' pollen produced 96 seeds.

"In 1878 I sowed in my garden with great care the seeds of the two lots separately at distances of 20 centimeters. The 120 seeds derived from fertilization with fresh pollen produced 112 plants, of which only six were female, all the rest being male. But the other 96 seeds, sprung from fertilization by stale pollen, produced 89 plants, every one of which was female. I have several times since repeated the experiment, always with a similar result."

Having reached this result in plants, Ciesielski extended his investigations to animals, and tested his theory in numerous experiments with rabbits, dogs, horses, and cattle, an overwhelmingly large number of which, he states, served to verify his previous results. Finally, Ciesielski declares that he has repeatedly recorded the application of the same law in man also.

To sum up: According to Ciesielski the sex of the progeny is governed by the conditions of fecundation and the law discovered by him applies to all living beings, whether plants, animals or man. In dioecious plants fresh pollen produces male seeds, while the effect of stale pollen is the production of female seeds. Similarly the sex in animals is determined by the age of the spermatozoa at the time they unite with the ova.

In plants this discovery will be of more or less academic interest, but in its relation to animals and man the results are sure to be important and far-reaching—*if it endures the light of the continued experimentation* to which this new "law" is already being subjected.

Nature and Time of Segregation

That segregation of unit characters may occur in somatic divisions is the contention of William Bateson. Discussing the subject before the seventeenth International Congress of Medicine, he said:

"First, as to the nature of segregation. This, I think, we must regard as a process comparable with the mechanical separation of substances which will not mix, or mix imperfectly; whereas some factors are continually transmitted in their entirety, others are liable to be broken up by what I regard as a process of quantitative fraction occurring in the mechanical dissociation of the elements at certain critical cell divisions. As to which are the critical cell divisions, we have no clear indication. I cannot agree with those of my colleagues who think segregation must occur exclusively in the maturation processes. The case of the double stock, in which the whole male side of the plant differs genetically from the female side, as proved by Miss Saunders, shows almost conclusively that segregation may occur in somatic divisions. It is also difficult otherwise to interpret the fact that in certain cases the parental combination influences the distribution of factors among the gametes so that the distribution among the grandchildren is different according to the way in which the characters were combined in their grandparents."

WEAKNESS OF ELDEST SONS

Statistics of Physical Examinations at Amherst College Seem to Bear Out Theory That Younger Sons are Physically Superior to the First-Born—Age of Parents Does Not Appear to Exercise Much Influence.

JOHN H. CHASE, *Youngstown, Ohio.*

FEW factors in constructive eugenics have been more emphasized during recent years than the desirability of large families among superior people; and this factor received particular attention when English biometrists published studies purporting to show, as one reason for the advantage of large families to society, that the elder children were inferior to those who followed; and, consequently, that the general average of the family, if small, was considerably below what it would have been if larger.

Karl Pearson, of London, the most noted proponent of this theory, was convinced that first and second born children are on the average inferior to their later born brothers and sisters, not only physically, but mentally and morally as well. In his pamphlet on "The Problem of Practical Eugenics," Pearson said:

"If our observations are correct, and I believe them to be so, then the mental and physical condition of the first and second born members of the family is differentiated from that of the later members. They are of a more nervous and less stable constitution. We find that the neurotic, the insane, the tuberculous and the albinotic, are more frequent among the elder born. Dr. Goring's results from criminality show the same law. . . . In the tuberculous, the insane and criminal stocks, the first few members are weighted. But the result of this new law is remarkable. It means that if you reduce the size of the family, you will tend to decrease the relative proportion of the mentally and physically sound in the community."

A proposition of such direct application and popular interest naturally aroused widespread attention. T. B. Macaulay, a Montreal member of the American Genetic Association, critically analyzed the statistics,[1] and declared that the conclusions drawn from them were a mere statistical fallacy. Others followed him, until the method of compiling the statistics on which the theory rests was to a large extent discredited.

This method was to take the records of some institution—a sanatorium or penitentiary, for example—as a basis. The inmates were questioned as to the number of children in the families to which they belonged, and their own order in the families. The number of first-born inmates was compared with the total number of first-born children in the families; and so on with the second, third and later born. The percentages thus found have been higher in the case of early born inmates than of later born. It has been pointed out, however, that this result has no significance, and must necessarily follow, because the younger members of families are, quite naturally, not as numerous as the older ones in groups of adults, whether such groups be undesirable, as the tuberculous, the insane or the criminal, or unobjectionable, as doctors, lawyers, clergymen, heavyweights, married men or fathers. By statistics compiled in this way, it is argued, it would be possible to "prove" that elder born children are superior to the younger born, quite as easily as that they are

[1]In the American Breeders' Magazine, Vol. II, no. 3, p. 165, July, 1911. He also called attention to the matter at the Eugenics Congress in London, 1912.

inferior. The theory thus falls to the ground, in the opinion of many, from lack of proof.

With the desire to test the theory by a method which would obviate the objections raised against that of Pearson and his co-workers, I investigated the records of the physical examinations of students who have entered Amherst College for a number of years past. At this institution Dr. Edward Hitchcock was the first man in charge of a collegiate physical department in America to establish anthropometric measurements and strength tests. He worked out a system of examination which was so thorough that there has been found no reason for changing the tests in more than 40 years. Each incoming freshman class has been measured and tested in the same way during all that time.

Thus a disinterested and reliable means of making an investigation as to the comparative strength of brothers was furnished; and as all those included in the data are adults, to the extent at least of being old enough to enter college, the fallacy pointed out by Macaulay in Pearson's studies is here obviated.

With the cooperation of Amherst authorities, I secured a list of 58 sets of brothers, from the physical examination charts. A correspondence was conducted with these individuals, particularly with a view to learning the ages of their parents, and their own order in the fraternities. Some of these sets of brothers included three individuals; most of them only two. Some of the sets I was obliged to disregard, in various computations, for various reasons.

In grouping the records of strength tests, I found first-born brothers strongest in four cases, second-born brothers strongest in 12 cases, and third-born strongest in 28 cases. As the individuals concerned came to college at about the same age, on the average, it seems clear enough that first-born brothers who came to Amherst were weaker than their younger brothers who followed.

Handling the figures in a different way, it was found that first-born brothers made a total of 11,361 points in the strength tests, second born had 12,510, and third born 13,251. The average strength of each individual in each class was: first born, 494 points; second born, 544 points; third born, 576 points. Of course, with such a small group of men, a few exceptional individuals would make a considerable change in the totals, and we know that there were exceptional individuals. Nevertheless, the results are so consistent as to make me confident that in this case the comparative strength of the brothers is faithfully represented by these figures, which seem to indicate that second-born sons were about one-tenth stronger than first-born sons, and that third-born sons were correspondingly stronger still.

Out of all the records taken, there were only 20 boys who made more than 600 points in the strength test on their entrance to the college, while there were only 14 who were below 450. Suppose, then, we say that those below the 450 mark are weaklings, those about 525 normal, and those above 600 strong. This makes 75 points as the difference between a normal young man and a weakling on one side, and an exceptionally strong man on the other side.

And this is just about the difference in the average strength of the first-born and third-born sons who entered Amherst College.

Taking only the two older of each of these sets of brothers, I added three more similar pairs for which the same data were available, and tested them on height and weight, as well as strength. Without going into details, I give the results:

Younger brothers were heavier in 24 cases; older brothers were heavier in 23 cases.

Younger brothers were taller in 22 cases; older brothers were taller in 25 cases.

Younger brothers were stronger in 30 cases; older brothers were stronger in 17 cases.

The interpretation of these results may afford room for some dispute; but as the disparity in strength is still marked, it seems to me merely to indicate that height and weight have little bearing on the question of strength or

constitutional superiority. I believe this conclusion is not out of harmony with our observations on those about us in daily life.

Of course, statistics on this point are always open to the obvious explanation that children of immature parents are likely to be of inferior physique. That is an entirely different question, which depends on the age of the parents, and not on the order of birth, or the size of the family. However, in order to find whether any light was thrown on my results, I secured information from as many of the brothers as possible—30 pairs or 60 individuals—as to the ages of their parents, and then compared the records of the individual students with the ages of their parents when the individual was born.

Out of the 60 different cases, there were seven men who had records of over 700 points in their strength tests. The strongest man in the group totaled 859 points; I learned that his father was 40 years old and his mother 42, at his birth. The second strongest had 809 points to his credit; the age of his father at the time of his birth was 49 years, and of his mother, 35. Of the other five strong men, in order of rank, the ages of the parents were as follows:

Father 50, mother 30; father 33, mother 31; father 28, mother 28; father 47, mother 33; father 42, mother 28.

The average age of the fathers was 41 and of the mothers 32.

I should be the last one to attempt to lay down any conclusions from such a small number of cases, but I may at least point out that these figures are unusual, if we accept the widely-quoted view that the best period for the production of children is between 20 and 30.

Summing the ages of the parents of the students whose strength I have called "normal," I found that the fathers averaged 38 and the mothers 31 years of age, at the birth of the sons in question. When the weakest students in our list were considered, their parents were found to have been, on the average, 36 years old (father) and 30 (mother) at the time of their birth. In such a small group, the slight decrease in age of parents, correlated to weakness in sons, can hardly be held to have any significance; and that it has no significance in these figures is further indicated by another test I made to check it. I picked out all the parents who had their first child after they were 30 years old, and compared the strength records of these first children with the records of the other first born, who were born before their parents reached the age of 30. The children of older parents averaged 500 points against 494 for the children of younger parents—a difference so slight as to amount to identity. It is obvious, then, that as far as these cases are concerned, the age of the parents has little appreciable effect on the strength of their children; but it must be noted that practically all the parents under consideration were mature, and even considerably beyond the usual age for the beginning of parenthood.

The question whether first-born children are inferior is still far from settled. Assuming for the moment that they are inferior, we still have to seek a cause for such inferiority. One of the most popular explanations does not concern itself with heredity at all, but supposes that the younger children profit by being kept constantly on their mettle, in order to make a favorable showing in comparison with the older ones; the eldest, on the other hand, are not obliged greatly to exert themselves in competition with the younger ones. My investigation of these Amherst students does not, of course, pretend to settle any of the questions involved, but I offer it as a contribution which at least avoids the fallacy charged to Pearson. Summing up, it indicates that the eldest sons are physically weakest, and that this weakness has no relation to their weight or height. If the age of their parents at birth has any influence on the figure, it is slight.

EXTINCTION OF FAMILY NAMES

Algebraical Computation Shows That if World Lasted an Infinite Length of Time, All Inhabitants Would Have Same Surname—Investigation of German Villagers Shows That Process of Extinction, Although Certain, is Slow.

Compiled by the Editor.

THAT every family name must die out sooner or later, was suggested by Alphonse de Candolle many years ago. Sir Francis Galton caught up the suggestion and proved its truth by mathematical computation. A German investigator has lately analyzed the data from 1400 marriages, in order to find out exactly in what way the extinction takes place, and reaches the conclusion that the probable extinction of any family can be foreseen one or two generations before the line actually runs out, and that as a general rule, when the decline has set in, nothing can stop it.

"In the accurate information and sensible statements of Benoiston de Chateauneuf, Galton and other statisticians," said de Candolle in his *Histoire des Sciences et des Savants* (1873), "I have not noticed the very important conclusion which they ought to have made, on the *inevitable* extinction of family names. Obviously all names must finally disappear. A mathematician could calculate how the reduction in the number of names and titles takes place, according to the probability of wholly female or wholly male births, or births of both sexes, and according to the probability of the absence of births with any given couple."

Galton's own reflections on the subject were as follows[1]:

IMPORTANCE OF THE PROBLEM.

"The decay of the families of men who occupied conspicuous positions in past times has been a subject of frequent remark, and has given rise to various conjectures. It is not only the families of men of genius or those of the aristocracy who tend to perish, but it is those of all with whom history deals, in any way, even such men as the burgesses of towns, concerning whom Mr. Doubleday has inquired and written. The instances are very numerous in which surnames that were once common have since become scarce or have wholly disappeared. The tendency is universal, and in explanation of it, the conclusion has been hastily drawn that a rise in physical comfort and intellectual capacity is necessarily accompanied by diminution in 'fertility'—using that phrase in its widest sense and reckoning abstinence from marriage as one cause of sterility. If that conclusion be true, our population is chiefly maintained by the 'proletariat,' and thus a large element of degradation is inseparably connected with those other elements which tend to ameliorate the race. On the other hand, M. Alphonse de Candolle has directed attention to the fact that, by the ordinary law of chances, a large proportion of families are continually dying out, and it evidently follows that, until we know what that proportion is, we cannot estimate whether any observed diminution of surnames among the families whose histories we can trace, is or is not a sign of their diminished 'fertility.' * * * Although I have not hitherto published anything on the matter, I took considerable pains some years ago to obtain numerical results in respect to this very problem."

A MATHEMATICAL SOLUTION.

Galton then quotes the solution of the problem worked out for him by Rev. H. W. Watson, supposing N to repre-

[1]Galton, Francis, Natural Inheritance, p. 241. London, 1889.

sent the number of adult males in a population, each with a different surname. After complicated computations, which represented five generations, and are far too abstruse to be understood by anyone but a mathematician, he successfully solves the problem algebraically, concluding:

"As, therefore, time proceeds indefinitely, the number of surnames extinguished becomes a number of *the same order of magnitude* as the total number at first starting in N, while the number of surnames represented by one, two, three, etc., representatives is some infinitely smaller but finite number. When the finite numbers are multiplied by the corresponding number of representatives, sometimes infinite in number, and the products added together, the sum will generally exceed the original number N. In point of fact, just as in the cases calculated above to five generations, we had a continual, and indeed at first, a rapid extinction of surnames, combined in one case with a stationary, and in the other case an increasing population, so it is when the number of generations is increased indefinitely. We have a continual extinction of surnames going on, combined with constancy, or increase of population, as the case may be, until at length the number of surnames remaining is absolutely insensible, as compared with the number at starting, but the total number of representatives of those remaining surnames is infinitely greater than the original number."

Mathematics, then, indicates that if the world would only last an infinite length of time, all its inhabitants would have the same surname. It is interesting to see how rapidly the process proceeds in actual experience, even among a people where the birth-rate is high.

A SOLUTION FROM LIFE.

The investigation has been followed out by Dr. Fr. von den Velden[2] from a statistical point of view, on the basis of figures compiled by Riffel[3] concerning 1400 marriages of peasant families in Baden. Considering the nature of the material, it will be admitted that the number of family lines which ran out is much smaller than would have been the case had the data been secured in a large city, or among people of a higher social class. The writer's figures may fairly be considered to represent the extent of family-extinction under the most favorable circumstances for continuation.

He begins by pointing out that we are accustomed to speak of a family as becoming extinct when the male line, and with it the family name, disappears. This is misleading physiologically, because the female line is of equal importance with the male line, to the biologist. He therefore investigates his data in regard to both lines.

Considering the various causes which may contribute to the extinction of a family, Dr. von den Velden says, "The simplest case is when a family remains absolutely childless. The causes of this rather rare occurrence (in the material here used 3% of the marriages are unfruitful) are to be sought in a minority of cases in the fact that one of the partners is of advanced age; more often—probably in two-thirds of the cases—the reason is that one of the partners is weighted by heredity. It is not to be understood that he or she inherits sterility; but sterility ensues as a result of some disease, a tendency to which has been inherited.

MARRIAGES WITH ONE CHILD.

"Equally rare with unfruitfulness is the case when, although children are born, none of them reaches marriage. In the material at hand we find 33 such marriages, or 2.3% of the whole. The average number of births in these marriages is 3.8. Marriages which result in only one child predominate, but on the other hand we find one with

[2] "Aussterbende Familien," von Dr. Fr. von den Velden (Frankfort a M.), in Archiv. f. Rassen u. Ges. Biologie, VI, 3, 340.

[3] Riffel's well-known genealogical-nosological tables were published in Mitt. über die Erblichkeit und Infektiosität der Schwindsucht (Braunsch. 1892) and Schwindsucht und Krebs (Karlsr. 1905).

11 children, all of whom died before the twentieth year, a second with 10 children, eight of whom died young, while the other two were feeble-minded. Of the 87 children included in the class under discussion, 80% died before reaching the twentieth year, 8% are phthisical, and only a single one of the number passed the sixtieth year. This lamentable constitution of children finds its explanation, with the exception of a few cases, in the condition of health of the parents."

"Up to this point we have dealt with the entire extinction of a whole generation, whether due to the production of no offspring at all, or the production of no fruitful offspring. It is more interesting to consider the extinction of the male line alone, since that is commonly identified with the extinction of the family."

"In this connection," says Lorenz[4], "the cases are particularly noteworthy where the deficient production of boys is balanced by an over-production of them in the immediately preceding generations. This happens so frequently that one is inclined to suspect a causal relation." He cites many instances to prove it, and Riffel's tables allow a striking confirmation of his remark. If one groups the fathers of families which consist only of girls (or at least, no boys which reached more than five years of age), the brothers and sisters of these fathers show the following sex proportion:

197 boys to 100 girls (Huttenheim)
146 boys to 100 girls (Stupfaich)
149 boys to 100 girls (Herlsdorf)
160 boys to 100 girls, the average in such cases, taking the total for the three villages.

DISPROPORTION OF BOYS.

Since the average for the whole population is 106 boys born, for every 100 girls, the disproportion of boys in the generation of the father whose family is about to become extinct in the male line, is altogether surprising.

"Very different, on the contrary, is the sex-proportion in the generation of the mothers of families which consist only of girls (not counting boys who died in infancy). Here the girl births are in the majority, and in the two Riffel tables in question we find a proportion of 93 boys to 100 girls, in place of the 106 boys to 100 girls which the general average of births in the empire would require.

"We see, then, that extinction of the male line is preceded (as a rule, and in the average) by a great disproportion of male births in the father's generation, and an overweight of female births in the mother's generation. Using a figure of speech, we may say: The male line blooms itself to death, and the excess of boys is suddenly transformed to an excess of girls, through marriage with a woman in whose family girl births have been in excess. So long as one regards such a statement merely as an aid to memory of the facts, it will not be misleading."

As to the frequency of extinction of male lines in the 1400 marriages now being considered there "are 84 (6%), among the offspring of which only daughters attained marriage. Extinction in the male line therefore seems to have about the same frequency as the complete extinction of a family, since there were found 3% of childless marriages and 2.3% of marriages which produced no fruitful offspring. That only daughters married, in these 84 families, is by no means to say that there were no sons in the same families; but those who existed died before the age of marriage or remained celibate; the latter, however, is an extremely rare occurrence in these villages of Baden. As a matter of fact, a large majority of the families, from which only daughters married, also produced sons—in only 20 out of the 84 were sons completely lacking[5]. In the rest, the sons died young.

USUAL FORM OF EXTINCTION.

"Out of these 84 families which became extinct in the male line but con-

[4]O. Lorenz, Lehrb. der gesamten wissensch. Genealogie, p. 482, Berlin, 1898.

[5]In 44 families only sons married, but in only 14 of these were no daughters born at all.

tinued in the female line, we get 44 in which only one son married, and 18% of these families died out completely in the following generation. In the families where no son married, but one or more daughters married, we find that 33% became totally extinct in the following generation. We can then conclude that the usual form of gradual extinction of a family (as opposed to immediate extinction through childlessness, or through the production of wholly unfruitful children) is usually preceded by the extinction of the male line: first, no more boys are born; later, no more children of either sex—at least none which reach marriage."

"It will now be interesting to compare the children produced during these two different kinds of gradual extinction: first, where the male line is reduced to one individual, and, second, where the male line is extinct, leaving the family to be carried on by daughters alone. The condition of the children is about equally unfavorable in each category. The average number of children is higher, however, when there is still a son who reaches marriage—thus:

With marriage of a single son—6.2 children, 10.3 grandchildren.

With marriage only of daughters—4.8 children, 6.8 grandchildren.

From a survey of all the cases[6] it is further evident that the average condition of health in families whose extent is decreasing, is inferior, and further deteriorates with each generation. In cases where there was only one man in the fraternity who married, there are still 4.6% of the children of such individuals, who passed the sixtieth year without inherited defects; but in the grandchildren the proportion is reduced to 1.6%; and thus the male line runs out."

"Accordingly, where a family has once started to die out, the deterioration of its constituents is progressive—well-marked, on the average, although of course single cases may offer exceptions. That a family threatened with extinction during one or two generations can recover itself, is a matter of every-day knowledge to us: but such a recovery is the exception, not the rule."

Possibility of Quick Returns

The want of systematic study of heredity is due chiefly to misapprehension. It is supposed that such work requires a lifetime. But though for adequate study of the complex phenomena of inheritance, long periods of time must be necessary, yet in our present state of deep ignorance almost of the outlines of the facts, observations carefully planned and faithfully carried out for even a few years may produce results of great value. In fact, by far the most appreciable and definite additions to our knowledge of these matters have been thus obtained.—William Bateson: Mendel's Principles of Heredity (1902).

What Eugenics Promises

There can be no question that among the promises of race-culture is the possibility of breeding such things as talent and the mental energy upon which talent so largely depends. . . . Eugenics can reasonably promise, when its principles are recognized, to multiply the human and diminish the vegetable type in the community. In so doing it will greatly further the production of talent, and therefore of that traditional or acquired progress which men of talent or genius create. Such a result will also further, though indirectly, the production of genius itself. For, as Mr. Galton points out, "men of an order of ability which is now very rare, would become more frequent, because the level out of which they rose would itself have risen."—C. W. Saleeby: Parenthood and Race Culture (1909).

[6]Dr. von den Velden sums up his cases in a table, which is here omitted because of its length.

THE PHILIPPINE NEGRITOS

Three Fundamental Types of Mankind Seem to Enter Into Their Make-up, but the Australoid Predominates—This May be Either the Basic Stock of All Humanity, or a Product of the Fusion of European and Oriental Stocks, the Iberian and the Primitive.

Extracts from two articles by Robert Bennett Bean of Tulane University, New Orleans, La., in the *American Anthropologist*.[1]

THERE are three fundamental types which are found among all the peoples of the Philippines, and the three types I have designated Iberian, Primitive and Australoid. The Iberian is of the classic Greek mold, thin, wiry and trim, and may be differentiated from the other types by the ear form, cephalic index and nasal index. The ear is characterized by the eversion of the concha, the rolling out of the helix, and the spiral shape of the outer rim, as seen from behind; the cephalic index is low the nose long and aquiline. The type is called Iberian because the purest living representatives are to be found in Spain, the Iberian peninsula.

The Primitive is in direct contrast to the Iberian because of the stocky build, usually short, squat and fat; the ear is distinctly bowl-shaped, with depressed concha and rolled-in helix; the head is short and broad, and the nose is short, broad and flat, with depressed root. The type is called Primitive, because it is infantile, because it is called Primitive by Hagen, and because it is found largely among the so-called Primitive peoples of the earth.

The Australoid is neither thin and delicately molded nor squat and fat, but is rather lanky and heavy in body and limb. The ear is large, somewhat bowl-shaped, with a sloping shelf for lobule, and the helix is horizontal in its upper part, making a square bowl instead of a round one as in the Primitive. The head is long and narrow, but the nose is broad, long, high and large in all dimensions. This type is called Australoid because it is believed to be the fundamental type of Australia and of all negroid peoples.

The Australoid is the fundamental Negrito type and it is found purest among the Mariveles Negritos and along the eastern coast of Luzon. It is also found elsewhere throughout the islands in populations that are not Negrito, where it is somewhat modified but has a form that is clearly recognizable. It has been found by me wherever I have observed Filipinos, and is one of the three fundamental types of the islands.

ORIGIN OF THE THREE TYPES.

The origin of the three types is not entirely clear. There can be no doubt that the Iberian is the same as the Mediterranean race of Sergi, derived originally from Europe. The Primitive has a wide range of distribution according to Hagen, being found in South America, Africa, the Pacific islands, and on the mainland of Asia. Wherever found it has associated with it a type resembling the Australoid, therefore the two may have originated together. If they did not, they have at least drifted together over the world and are found together at present over a large extent of the earth's surface. The Australoid type is a large element in the composition of the negro people,

[1]This article is a mosaic of extracts from the concluding portions of two papers by Dr. Bean: "Types of Negritos in the Phillipine Islands" (Am. Anthropologist, Vol. 12, No. 2, 1910) and "Philippine Types" (Ibid., Vol. 12, No. 3, 1910). The Editor is wholly responsible for the selection of these extracts.

FRUIT VENDERS FROM NEGROS ISLAND, P. I.

"It has been asserted repeatedly that the body color of the Negrito is black," says David P. Barrows, "but this is a gross exaggeration. It is a dark brown." "The hair of the Negrito is typically African. It is kinky and grows in the little clusters or 'peppercorn' bunches peculiar to negro races." Dr. Bean says this kinkiness of the hair behaves as a Mendelian dominant in crosses. The Negritos shown in this picture (taken at Camp Jossman) are selling fruits of the Jak (*Artocarpus integrifolia*), the largest fruit known, and closely related to the commoner bread-fruit (*Artocarpus incisa*). (Figure 11.)

judging from observations on many hundreds of American negroes.[2]

The Negritos in the Mariveles mountain appear to be the purest Negritos in the Philippine Islands, judging from the photographs. All other groups of Negritos are more like the surrounding population. The Negritos of Mariveles should therefore represent the fundamental Negrito type, and as they are largely Australoid the fundamental type of the Negritos should be Australoid. Modified Primitive and Modified Iberian Negritos are also found in the Mariveles group. The women are more Primitive than the men, who are more Iberian

[2]"The photographs of the Mariveles Negritos were all placed upon a large table before me, and when I scrutinized them carefully I realized that I was looking into the faces of a familiar people, among whom I was born and with whom I grew up, the American negro. Practically every face recalled youthful associations, and every individual of the Mariveles group has its counterpart among American negroes."—Bean

and Australoid than the women. The Primitive and Iberian characteristics of the Mariveles Negritos are of such a nature that they should be considered as remnants of the fusion that must have progressed for many centuries or even thousands of years to have produced so homogeneous a blend.

The origin of the Negrito may never be known, but it seems plausible that the Australoid is the true Negrito type on which the Iberian and the Primitive types have been grafted. The Iberian came from Europe by way of India in prehistoric migrations, and their combinations with the Australoid are represented by the Negritos of Mariveles mountain and those of the eastern coast of northern Luzon. The Primitive came from the Orient, and has mingled with the Iberian-Australoid Negrito throughout the Philippines, altering the form and straightening the hair of the purer Negritos that existed before. The more recent European contact with the Negrito has had very little apparent effect, although an occasional pure Iberian may be found with dark skin and kinky hair. The Negrito element has entered to a considerable extent into the present Filipino population, although it may not be recognized with ease because of the absence of kinky hair. The Negritos have been losing their identity by becoming incorporated into the body of the surrounding population. Where once the Negrito was found in all parts of the archipelago, the only remaining centers in which they exist in anything like their original purity are the two already mentioned, Mariveles mountain and the eastern coast of Luzon. In all other parts the kinky hair has practically disappeared and the Negritos have taken on the form of the surrounding population, distributing their own forms throughout the regions roundabout.

CHARACTERS IN HEREDITY.

Any conclusion reached after a study of the photographs presented[3] must be tentative and subject to revision. It does appear, however, that there are many inseparable factors in the composition of the individual, such as the ear-form, nose-form and face-form, and length of the extremities, that constitute a "character-complex" which exists as an entity and in inheritance may act as a unit character.

A "character-complex" is that group of characters, such as the broad head, broad nose, broad face and characteristic ear, that, combined with small stature, constitute the Primitive species, which character-complex usually hangs together in heredity, but may break up when crossed with alien forms to create new character-complexes.

There is blending of one character-complex with another, but this blending probably does not take place at once upon crossing two extremely different character-complexes such as the Iberian and the Primitive, or the Iberian and the Australoid, but results in the reappearance of one or the other character-complex in pure form. . . .

From this follows the second conclusion, which is that the kinky hair is dominant over the straight hair when the cross takes place among the Negritos; therefore a character-complex may be obscured by kinky hair, so that an otherwise pure Iberian may appear to be a Negrito because of the character of the hair.

The following conclusions are tentatively made from observations of Europeans, Filipinos and negroes. The Iberian is the fundamental European type, but modified Primitive and Australoid types may be found among Europeans besides the composite types, such as the Alpine, B.B.B.,[4] etc. The Australoid is the fundamental negroid type, but a great many Iberian and Primitive forms are found among negroes, and the composite types are also present. The Primitive is the fundamental type of the Orient and of the Pacific peoples, but both Iberian and Australoid as well as the composite

[3]This refers to the photographs presented by Dr. Bean in his original articles. He is not in any way responsible for the photographs in these pages.

[4]The B. B. B. is the big-cerebellumed, box-headed, Bavarian of Ranke, so-called by Beddoe. —Bean.

A NEGRITO-TAGALOG CROSS.

Although this man (25 years old, 4 feet, 4¾ inches high) claimed to be half Tagalog, his type is purely that of the Mariveles Negrito, the purest of the Philippine Negritos and most resembling the original Australoid stock. "The only other undisputed members of the Negrito race, besides those found in the Philippines," says David P. Barrows, "are the Andaman islanders and the Semang of the Malay peninsula." "He is a scattered survivor of the pygmy negro race, at one time undoubtedly far more important and more numerous; brachycephalous, platyrhinian, woolly headed, and, when unaffected by the higher culture of the surrounding peoples, a pure forest dwelling savage." This photograph of an inmate of Bilibid Prison, Manila, is from the "Album of Philippine Types" by Daniel Folkmar, Manila, 1904. (Figure 12.)

types are to be found there. Among Europeans the other types resemble the Iberian; among negroes the other types resemble the Australoid; and among Orientals the other types resemble the Primitive.

May it be presumed that the Primitive and Iberian types conjoined in prehistoric times at some place in the East of Asia or nearby, and produced by fusion the Australoid. From this union innumerable offshoots have sprung in Southern Asia, the islands bordering that region, and in Africa. The Primitive type remains pure in parts of the East, and the Iberian type in Europe. If this hypothesis be untrue, the reverse of it should be considered; viz., the

Australoid forms the basic stock of all humanity, and the Iberian of Europe on one side and the Primitive of the Orient on the other are derivatives. If neither hypothesis be true, at least the Negrito of Mariveles has Primitive and Iberian characteristics ingrafted from without.

ANCIENT TYPES STILL EXIST.

The composition of any group of people, large or small, depends on the relative proportions of each type that entered into the composition of the group, the time during which the types have been in contact, the conditions of food, water, air, habits, etc., and other factors. There is no evidence that any type of man that ever existed has disappeared entirely, although there is evidence that the types have become somewhat modified in different parts of the world.

My recent discovery of paleolithic man in the Philippines (*Homo philippinensis*) may throw light on the origin of the Australoid type among the Negritos and among the inland tribes as well as in the littoral population of the archipelago. *Homo philippinensis* is Australoid in form yet somewhat different from the Negrito Australoid, the Igorot Australoid or the Australoid of the coast, but not so different as to preclude all relationship. *Homo philippinensis* is also related to the earliest forms of man in Europe: *Homo monsteriosis* and *Homo Heidelbergensis;* it is of the Neanderthal type, and is not greatly different from the Negro Australoid. The following hypothesis is plausible. Primordial man remained practically unaltered in form in Africa and the Pacific, and *Homo philippinensis* is this unchanged form; but in Africa the kinky hair and black skin of the negro may be added features due to environment, and the Australoid negro is a further modification of the negroid form, due also to environment. Whatever the cause may be, there are at present three types found among the Negritos—the Australoid, the Primitive and the Iberian; and these three types are found also among the other peoples of the Philippines wherever I have examined them. The Primitive and the Australoid, and doubtless the Iberian, are found in all the islands of the Pacific where search has been made and careful analysis of the people has followed, the first two types often among more or less pure Negritos.

The more profound the study, the more profound becomes the impression that the Primitive, the Australoid and the Iberian are the three fundamental types of mankind.

A Race of White Canaries

Establishment of a race of white canaries is described in a recent number of Knowledge, by Maud S. Martin. It started with a hen from a much in-bred buff strain, that sported to pure white, and was mated with an unrelated buff male. All of the offspring were buff, but when bred together gave 48 buff chicks and 18 white ones. Matings carried through the third generation seemed to prove that the color was subject to Mendelian laws, buff being dominant and white recessive. Twenty-five extracted recessives were secured and are now breeding pure in every generation. They seem to be fully as vigorous as the type, and have black, not pink, eyes.

A Eugenics Bibliography

The Russell Sage Foundation Library of New York City has published (as number three of its bulletin, February, 1914) a useful selected list of works on eugenics, from the material represented in its own collection. It is interesting to note that only 24 out of the 57 entries are due to Americans. Unfortunately, the list does not, for the most part, include the subjects of heredity and genetics, unless they deal solely with the eugenics phase.

THE REASON FOR EUGENICS

Religious Duty of Man to Assist the Course of Evolution and Endeavor to Make it Less Slow and Painful—His Power to do so Shown by the Results of His Half Unconscious Efforts in the Past.

Francis Galton.[1]

OUR ignorance of the goal and purport of human life, and the mistrust we are apt to feel of the guidance of the spiritual sense, on account of its proved readiness to accept illusions as realities, warn us against deductive theories of conduct. Putting these, then, at least for the moment, to one side, we find ourselves face to face with two great and indisputable facts that everywhere force themselves on the attention and compel consideration. The one is that the whole of the living world moves steadily and continuously towards the evolution of races that are progressively more and more adapted to their complicated mutual needs and to their external circumstances. The other is that the process of evolution has been hitherto carried out with, what we should reckon in our ways of carrying out projects, great waste of opportunity and life, and with little if any consideration for individual mischance. Measured by our criterion of intelligence and mercy, which consists in the achievement of result without waste of time or opportunity, without unnecessary pain, and with equitable allowance for pure mistake, the process of evolution on this earth, so far as we can judge, has been carried out neither with intelligence nor ruth, but entirely through the routine of various sequences, commonly called "laws," established or necessitated we know not how.

An incalculable amount of lower life has been certainly passed through before that human organization was attained, of which we and our generation are for the time the holders and transmitters. This is no mean heritage, and I think it should be considered as a sacred trust, for, together with man, intelligence of a sufficiently high order to produce great results appears, so far as we can infer from the varied records of the prehistoric past, to have first dawned upon the tenantry of the earth. Man has already shown his large power in the modifications he has made on the surface of the globe, and in the distribution of plants and animals. He has cleared such vast regions of forest that his work that way in North America alone, during the past half century, would be visible to an observer as far off as the moon. He has dug and drained; he has exterminated plants and animals that were mischievous to him; he has domesticated those that serve his purpose, and transplanted them to great distances from their native places. Now that this new animal Man finds himself somehow in existence, endowed with a little power and intelligence, he ought, I submit, to awake to a fuller knowledge of his relatively great position, and begin to assume a deliberate part in furthering the great work of evolution. He may infer the course it is bound to pursue from his observation of that which it has already followed, and he might devote his modicum of power, intelligence and kindly feeling to render its future progress less slow and painful. Man has already furthered evolution very considerably, half unconsciously, and for his own personal advantages, but he has not yet risen to the conviction that it his religious duty to do so deliberately and systematically.

[1]These words of the founder of the science of eugenics are part of his chapter on "The Observed Order of Events" in *Inquiries into Human Faculty*, first published in 1883. The book is now obtainable at a cost of 35 cents, in "Everyman's Library", and should be in the possession of everyone who has even the slightest interest in eugenics.

"REVERSION" IN PRICKLY PEARS

Origin of All Spineless Varieties of Opuntia to be Sought in Long Selection From Spiny Ones—Plant May Produce Spiny Joints on One Side and Spineless Ones on the Other.[1]

David Griffiths,

Agriculturist, Office of Farm Management, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

In the economic handling of the prickly pear as a farm crop in southern Texas great differences have been found in the ease with which spines are burned from different species, and the differences are to a considerable extent matters of geographical position. Native species from the immediate vicinity of Brownsville have been employed in our economic plantings, because it was early recognized that these were the best adapted to the conditions and would make the largest tonnage of any that could be grown.

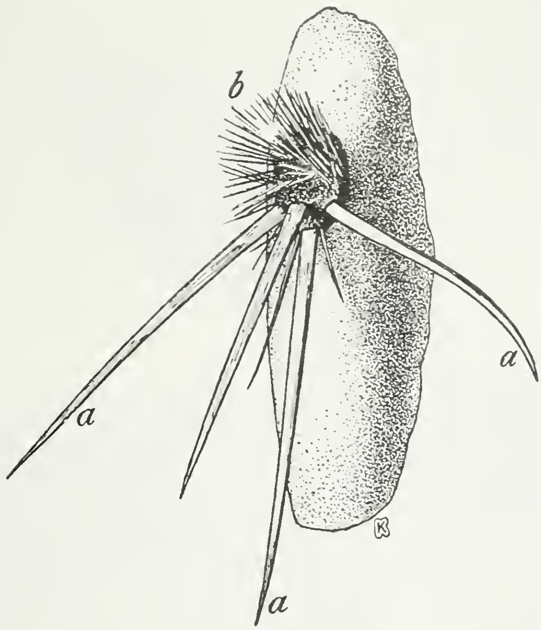
All species of this region are exceedingly spiny. They are even more spiny than those of the San Antonio region; moreover, the spines remain green for a longer period and are consequently much more difficult to singe properly preparatory to being fed. This is a serious economic consideration and one which is difficult to prevent. Under the humid conditions of the coastal region the tendency is for the spines (fig. 13, *a*) and the spicules (fig. 13, *b*) of all species to become dry much more slowly than in the more arid atmosphere of the regions farther inland.

In the cultivation of this crop it is therefore necessary for one to choose between the spineless forms not needing singeing and the much more productive spiny native varieties, which are not only difficult but often impossible to singe properly. It may be possible in time to breed varieties better adapted than the native ones, but the development of such forms from the spiny native prickly pears of the delta of the Rio Grande is an almost hopeless task, the variation in the number of spines produced being so trifling as to scarcely warrant selection, while they do not appear to hybridize readily with the spineless forms.

In June, 1905, the Office of Foreign Seed and Plant Introduction of this Bureau received from Dr. G. Borg, San Giovanni, Island of Malta, a few cuttings of a large spineless species, to which was assigned S. P. I. No. 14807. The plant passes in both this country and the Mediterranean region as spineless. About half a dozen cuttings of this importation were planted and grew for two and a half years at the plant introduction field station at Chico, Cal. They were then cut up into individual joints and re-established in nursery form in a plantation as extensive as the stock thus produced would permit. It was noticed that one of the original plants had on one of its joints three or four spines in one or two pulvini on one side. No heed was paid to this, however, and this joint was lost sight of in the planting, which was made in nursery form. In other particulars this did not differ from the other plants.

This prickly pear belongs to what commonly passes for *Opuntia ficus indica* and is nearly spineless. Frequently short spines are produced, but they are very few in number; there is but one in an areole, and they are usually only two to five or six millimeters in length. It is on the whole an average of the spineless forms. When

[1]This article is an extract from Mr. Griffith's Bulletin No. 31, U. S. D. A., "Behavior, under Cultural Conditions, of Species of Cactus Known as Opuntia," Washington, December 30, 1913.



SPINES AND SPICULES

A pulvinus, or cushion of spines (*a*) and spicules (*b*), from the edge of a joint of *Opuntia lindheimeri* from the San Antonio region of Texas. Ordinary "spineless cactus," although it may lack spines, often possesses spicules, which make it equally worthless for many of the purposes for which it is sold. It is only the most highly improved varieties that are absolutely free from spicules as well as spines, and hence suitable for feeding to live stock, without first being singed. (Fig. 13.)

the first planting of this stock was grown, one plant which was normally vigorous showed a few rather long spines, as stated above, similar in character to the shorter ones more commonly produced, but much longer and stouter.

The establishment of the nursery plantation took place in April, 1908. The following spring all of the spineless forms (especially S. P. I. No. 14807) were cut back to the original cutting for stock. At this time it was noticed that one side of one plant of this number was very spiny and the other side as spineless as the remainder of the importation. With the rest, this plant was cut loose, but the spiny cuttings were rejected. In the spring of 1910 the new growth was again in part spiny, and it was again cut back, but one joint was left attached to the original one. At that time neither joint left on the plant showed any spines.

In the spring of 1911 it was found that the previous season's growth had come mainly from the upper cutting, which grew in the season of 1909. From the original cutting two joints had sprung, one from each side. All new growth on one side of the plant, whether from the original cutting or from the younger joint, was practically spineless, while the other side was exceedingly spiny, the latter resembling the more common forms of some of the mission pears grown in all of the collections in southern California and bearing two to four white spines two-thirds of an inch to one and one-half inches long. The whole plant is shown in fig. 14.

The appearance of the plant in the spring of 1911 was so striking that it was pruned back but very little, simply enough to shape it up. Several of both spiny and spineless joints were planted, but owing to the condition of the

A CASE OF "DEMI-REVERSION"

This supposedly spineless Opuntia from the Island of Malta, when planted at Chico, California, began to develop spines—but only on a part of the plant. Sections taken from the spiny part produce spiny plants; cuttings from the spineless side produce plants which are spineless. Mr. Griffiths considers this to be a case of reversion which indicates that the original ancestor of the modern Opuntias was spiny. (Fig. 14.)

ground when the planting was done all made a very poor growth. However, the small amount of growth that was made came true to the characters of the individual cuttings planted. In the spring of 1912 the previous season's growth was again spiny on one side of the plant and spineless on the other, the contrast producing a very striking appearance.

This habit of reversion or bud variation, whichever it may be considered, is a very important characteristic, and, while more striking in the above variety than any other which has been cultivated in these investigations, appears to be not at all uncommon. A plant of another spineless variety on hand now bears promise to be just as conspicuous a few years hence as this one. It started to vary in the same direction last year.

All this relates, however, to the development of characters economically un-

desirable. It is well known that lack of spines is also a character which can be maintained by vegetative propagation, but being usually of slight variation is not as striking as the case mentioned of variation in an opposite direction. This phenomenon is an important one, for it furnishes a possible suggestion regarding the origin of the spineless varieties.

Both of these variations appear to the writer to point to the origin of the spineless species of the so-called *ficus-indica* group from the spiny ones, the spineless forms being the result of a long series of selection, both upon this continent and in the Mediterranean region, subsequent to their introduction there. The striking variation of certain spineless forms to a spiny condition is looked upon as a reversion to an original type.

Variation by Loss of Inhibitors

A hypothesis to explain variation by the appearance of new dominant characters as due to the loss of some single inhibiting factor, is put forward by William Bateson, director of the John Innes Horticultural Institution at Merton, Surrey, England, and the most distinguished exponent of Mendelism in England, in an address before the seventeenth International Congress of Medicine, reprinted in the Lancet.

"We have been accustomed," he remarks, "to speak of characters as added to or subtracted from the sum total of an individual composition, but as to the actual origin of new dominants there is very little contemporary evidence.

"In the case of those animals, such as the fowl, the wild original of which we think we know, many factors exist in our domesticated breeds which are not possessed by any of the wild species. No wild species, for example, has the complicated combs that are possessed by our domestic breeds. None has the dominant white color of the leghorn; and many other such instances might be given. How have these elements been added to the composition of the fowl?

" . . . but for one feature in the descent of dominants we might be tempted to suggest that they also arose through the introduction of some element from without into the system. I see no *a priori* impossibility in such a belief, but in these dominants we know that the distribution among the germ-cells is approximately symmetrical, and nothing that we know of animals or plants justifies the suggestion that a foreign element can be so treated in gameto-genesis. Perverse as such a suggestion may appear, I do not think we should close our minds to the possibility that these dominants arise by a process of some inhibiting factor. Until we have some far more direct method of recognizing the presence of factors this suggestion cannot be positively gainsaid."

The Importance of Genetics

Evolution, selection, heredity, environment, differential fertility, are not mere vague terms of biological science having no application to human life. On their right understanding depends the stability or collapse of human society in general and of our nation in particular.—Karl Pearson: Nature and Nurture (1910).

EFFECTS OF INBREEDING

A Valuable Instrument, But Fraught With Danger—Experiment Shows That if Long Continued, Its Effects are of Themselves Evil, Regardless of the Strength of Constitution of the Animals Involved.[1]

H. Kraemer,

Professor in the Landwirtschaftliche Hochschule of Hohenheim, Germany.

DURING the past few months I have been receiving a continually increasing number of inquiries about the present status of inbreeding. People are nowadays constantly reading and hearing of its absolute harmlessness, while until a short time ago it was held up to them as utterly unpermissible. It seems desirable, then, to review some of the results of experience, and to state my own views as to whether consanguineous breeding really results injuriously.

The reliable observations made for many years past in every possible branch of breeding and in all kinds of herds, have thoroughly illuminated the question for anyone who is able to follow the truth when he sees it. But I must conclude, from the great number of letters I receive, that men are not able to follow the truth very often. And although the conclusions justified by these breeding experiments be known, yet some emphasis should be laid on the other side as well. The new and better knowledge of the great value of properly-directed inbreeding will surely not cause anyone to go astray. And certainly it is not for a minute my intention to lead anyone astray on this subject.

The present age has directed researches about consanguineous breeding in the right direction. If we are thereby led to indorse in all branches of stock-breeding a procedure so much feared in earlier times, that lies in the nature of things. Our delight in the discovery of the high importance of a principle always leads us too easily to pass by the darker sides, the aspects which should cause us to hesitate; and the serious results following inbreeding are now too lightly regarded in handbooks of stock-breeding. And when isolated breeders go so far as to declare that inbreeding produces no serious consequences whatever, then it is again time to recall the innumerable cases recorded from the experience of well-known breeders of the past. In this retrospect, the literature of the various civilized countries in earlier days furnishes a picture that can not be misinterpreted, and I shall therefore attempt to present it here. Such a literary review will perhaps be able to correct our viewpoint while broadening it, now that the English breeders have become such unconditional friends of inbreeding.

DARWIN'S INVESTIGATIONS.

Among the English writers who have dealt with the subject, Darwin naturally comes first to mind. We are too much accustomed to think of his work as going wholly backward and dealing only with origins. I want, therefore, at this point to commend most warmly to breeders the perusal of his book on "The Variation of Animals and Plants under Domestication." What a mass of stimuli to us in our work! What a mighty faculty for observation! What a surpassing talent for bringing innumerable details together to make a unified picture! This book should be in the possession of every breeder who wishes

[1]Translation of "Uber die ungünstigen Wirkungen naher Inzucht," in Mitteilung der Deutsches Landwirtschafts Gesellschaft, 6 and 13 September, 1913.

to deepen his knowledge of all branches of stock-breeding.

In the seventeenth chapter Darwin discusses "The Good Effects of Crossing and the Evil Effects of Close Interbreeding." He states his own observations and cites a long list of English authorities, both theoretical and practical. In following his outline of the case, I shall also cite some of the older French and German breeders.

Since the time of von Lehndorff, we have become more exact in defining the closeness of inbreeding. Darwin himself complains that a definition of close breeding is difficult because the same degree of consanguinity in different species of animals is reached in different manners, yet today we hold gladly to the idea of "free generations" and the "line of ancestors," and apply it to all kinds of animals. Such an accurate measure is highly desirable here, and according to it the pairing of father with daughter or of mother with son is the closest degree of consanguineous breeding. Not improperly, however, does Darwin himself note on this point that as Sebright has remarked, the pairing of brother and sister is really the closest degree of family mating, because here like blood is mated to like, while father in mating with daughter unites with only half his own blood. If evil results occur from inbreeding, they must, therefore, be the most serious when siblings or members of the same fraternity (full brother and sister) are paired.

But can any evil results be proved from inbreeding itself? "That any evil directly follows from the closest inbreeding has been denied by many persons," says Darwin, "but rarely by any practical breeder; and never, so far as I know, by anyone who has largely bred animals which propagate their kind quickly. Many physiologists attribute the evil exclusively to the combination and consequent increase of morbid tendencies common to both parents; and that this is an active source of mischief there can be no doubt. It is unfortunately too notorious that men and various domestic animals endowed with a wretched constitution, and with a strong hereditary disposition to disease, if not actually ill, are fully capable of procreating their kind. Close interbreeding, on the other hand, often induces sterility; and this indicates something quite distinct from the augmentation of morbid tendencies common to both parents. The evidence immediately to be given convinces me that it is a great law of nature, that all organic beings profit from an occasional cross with individuals not closely related to them in blood; and that, on the other hand, long-continued close interbreeding is injurious."

PROOFS NOT ALL CONVINCING.

When the proofs that Darwin gives, many of which have already found their way into our textbooks, are examined most carefully, it must be admitted that it is sometimes very difficult clearly to recognize the evils of inbreeding supposed to be shown by them. The results are often only too general in their nature, and admit of being strongly influenced by the constitutional soundness or unsoundness of the animals concerned. And finally, a considerable decrease in strength of constitution may be accompanied with so much of advantage to the breeder that he will completely overlook it in many instances Whenever, therefore, the statements of breeders are subjective, they offer no proof, in the biological acceptation of the word; and often inbreeding may be credited with such and such results, when these results are due solely to breeding for high performance without regard to the constitution and vitality of the animals. As Darwin strikingly showed, an actual increase in vigor is clearly enough evident when cross-breeding is practiced. If this is undisputed, the conclusion ought to be well-established, that continuous line-breeding must finally call forth the opposite result.

Sebright, Knight, Youatt and Low have unanimously borne witness that continued close interbreeding is impossible. Prinsep also found that despite the best feeding, the growth of the animals steadily decreased, and John Sinclair expressly testifies that Bake-

well's method of breeding could not be carried on for any length of time with good results—although it was long in fashion because of Bakewell's great influence.

If Darwin did not appeal to these sources of evidence, it was not, of course, because they were not entitled to command respect. Besides, he refers only casually to Culley, although the latter is one of the most positive of the older English writers, on the absence of danger from inbreeding. The greatest hindrance to the improvement of breeds of live-stock, Culley declares, is due to the superstition that because of the danger of inbreeding, one should use the same bull only three years at the longest. Weak and delicate produce is feared, and many have fallen into the belief that inbreeding is abhorrent to religion. Happily, however, there are still people in England who have no regard for such superstitions, and the experience of many years justifies them. By the example of the half-wild cattle in Chillingham Park in Northumberlandshire, Culley seeks to demonstrate that even long-continued inbreeding is harmless. This race, the purest-bred in Europe, is hardy, sound and of good form, and has not changed in color for more than 500 years.

THE CHILLINGHAM CATTLE.

The Chillingham cattle are so often quoted in German literature that it seems worth while to give Darwin's remarks on the subject verbatim. Notice that according to his view even here inbreeding has not proved wholly innocuous:

"The half-wild cattle, which have been kept in British parks probably for 400 or 500 years, or even for a longer period, have been advanced by Culley and others as a case of long-continued interbreeding within the limits of the same herd without any consequent injury. With respect to the cattle at Chillingham, the late Lord Tankerville owned that they were bad breeders. The agent, Mr. Hardy, estimates (in a letter to me dated May, 1861) that in the herd of about 50 the average number annually slaughtered, killed by fighting, and dying, is about 10, or one in five. As the herd is kept up to nearly the same average number, the annual rate of increase must be likewise about one in five. The bulls, I may add, engage in furious battles, of which battles the present Lord Tankerville has given me a graphic description, so that there will always be rigorous selection of the most vigorous males. I procured in 1855 from Mr. D. Gardner, agent to the Duke of Hamilton, the following account of the wild cattle kept in the Duke's park in Lanarkshire, which is about 200 acres in extent. The number of cattle varies from 65 to 80; and the number annually killed (I presume by all causes) is from 8 to 10; so that the annual rate of increase can hardly be more than one in six. Now in South America, where the herds are half-wild, and therefore offer a nearly fair standard of comparison, according to Azara the natural increase of cattle on an estancia is from one-third to one-fourth of the total number, or one in between three and four, and this no doubt applies exclusively to adult animals fit for consumption. Hence the half-wild British cattle which have long been interbred within the limits of the same herd are relatively far less fertile. Although in an unenclosed country like Paraguay there must be some crossing between the different herds, yet even there the inhabitants believe that the occasional introduction of animals from distant localities is necessary to prevent 'degeneration in size and diminution in fertility.' The decrease in size from ancient times in the Chillingham and Hamilton cattle must have been prodigious, for Professor Rutimeyer has shown that they are almost certainly descended from the gigantic *Bos primigenius*. No doubt this decrease in size may be largely attributed to less favorable conditions of life; yet animals roaming over large parks, and fed during severe winters, can hardly be considered as placed under very unfavorable conditions."

GAME IN PRESERVES.

The question whether sustained close-interbreeding in game preserves leads to

degeneracy is also of great interest. One reads so much on this question without getting a distinct impression, that a real proof for the degenerative effects of inbreeding seems to be obscured by the very form in which it is presented. Darwin went into the question of deer at some length, and he finally comes to the general conclusion that continued interbreeding here, too, leads to harm.

"As some of our British parks are ancient," he says, "it occurred to me that there must have been long-continued close interbreeding with the fallow deer (*Cervus dama*) kept in them; but on inquiry I find that it is a common practice to infuse new blood by procuring bucks from other parks. Mr. Shirley, who has carefully studied the management of deer, admits that in some parks there has been no admixture of foreign blood from a time beyond the memory of man. But he concludes 'that in the end the constant breeding in-and-in is sure to tell to the disadvantage of the whole herd, though it may take a very long time to prove it; moreover, when we find, as is constantly the case, that the introduction of fresh blood has been of the very greatest use to deer, both by improving their size and appearance, and particularly by being of service in removing the taint of "rickback" if not of other diseases, to which deer are sometimes subject when the blood has not been changed, there can, I think, be no doubt but that a judicious cross with a good stock is of the greatest consequence, and is indeed essential, sooner or later, to the prosperity of every well-ordered park.'"

In referring to the longhorns of Bakewell, Darwin also takes the view adopted by Youatt. Continued inbreeding led in this case to a weakness of constitution not compatible with good management, and reproduction became uncertain. At the very commencement, however, Darwin naturally mentions the Shorthorns, among which the most extended use of inbreeding was notoriously made. So, says Darwin, "the famous bull Favourite (who was himself the offspring of a half-brother and sister from Foljambe) was matched with his own daughter, granddaughter and great-granddaughter, so that the produce of this last union, or the great-great-granddaughter, had 15-16ths or 93.75% of the blood of Favourite in her veins. This cow was matched with the bull Wellington, having 62.5% of Favourite blood in his veins, and produced Clarissa; Clarissa was matched with the bull Lancaster, having 68.75% of the same blood, and she yielded valuable offspring."

RESULTS WITH SHORTHORNS.

The numerous examples from Shorthorn herds show that consanguineous breeding of a very wide extent may be practiced without leading to the extinction of a herd. They do not show, however, that continuous inbreeding is in general uninjurious. Darwin himself well shows that even Collins practiced crossing. And while Bates, that successful breeder, practiced close inbreeding for 13 years, and had, as Darwin remarks, "the most exalted idea of the value of his herd," yet during the next 17 years he was obliged three times to introduce new blood into it. Bates himself said, according to Darwin's account, "that to breed in-and-in from a bad stock was ruin and devastation; yet that the practice may safely be followed within certain limits when the parents so related are descended from first-rate animals."

With sheep also, according to Darwin, inbreeding has been much practiced. Messrs. Brown are said never to have introduced new blood into their Leicesters during 50 years, and we have of course no right to question the truth of the breeders' statements in such instances. Mr. Barford, in the course of a half century, had come to the conclusion that inbreeding did no harm, if practiced on animals quite sound in constitution, but on the other hand he does not claim to have practiced breeding in the closest degrees of affinity. He adds, however, that most great breeders of sheep have protested against continued close interbreeding. Jonas Webb is said to have kept five separate families to work on, in order to retain the requisite distance of relationship between the sexes.

As concerns swine, Darwin also cites a long list of English witnesses, part of whom had written on the subject, and part of whom had given him their views orally. "With respect to pigs," Darwin says, "there is more unanimity amongst breeders on the evil effects of interbreeding than, perhaps, with any other large animal. Mr. Druce, a great and successful breeder of the Improved Oxfordshires (a crossed race), writes, 'without a change of boars of a different tribe, but of the same breed, constitution can not be preserved.' Mr. Fisher Hobbs, the raiser of the celebrated Improved Essex breed, divided his stock into three separate families, by which means he maintained the breed for more than 20 years, 'by judicious selection from the *three distinct families*.' Lord Western was the first importer of a Neapolitan boar and sow. 'From this pair he bred in-and-in, until the breed was in danger of becoming extinct, a sure result (as Mr. Sidney remarks) of inbreeding.' Lord Western then crossed his Neapolitan pigs with the old Essex and made the first great step toward the Improved Essex breed.

A REMARKABLE CASE.

"Here is a more interesting case. Mr. J. Wright, well-known as a breeder, crossed the same boar with the daughter, granddaughter, great-granddaughter, and so on for seven generations. The result was that in many instances the offspring failed to breed; in others they produced few that lived; and of the latter many were idiotic, without sense, even to suck, and when attempting to move could not walk straight. Now it deserves especial notice, that the two last sows produced by this long course of interbreeding were sent to other boars, and they bore several litters of healthy pigs. The best sow in external appearance produced during the whole seven generations was one in the last stage of descent; but the litter consisted of this one sow. She would not breed to her sire, yet bred at the first trial to a stranger in blood. So that, in Mr. Wright's case, long-continued and extremely close interbreeding did not affect the general form or merit of the young; but with many of them the general constitution and mental powers, and especially the reproductive functions, were seriously affected."

With regard to dogs an attempt has often been made to show that inbreeding has no influence, according to Darwin, Meynell's famous foxhounds, for example, being cited as having been bred closely in-and-in without the least trace of injury being discernible. J. Sebright, however, declares that he had seen "the offspring of strong spaniels degenerate into weak and diminutive lapdogs," as a result of the pairing of brother and sister. And W. D. Fox noted that with consanguineous breeding of bloodhounds a visible degeneracy took place, and that almost all the animals had an enlargement of the bones of the tail. A single crossing with foreign bloodhounds restored their fecundity and drove away the tendency to malformation in the tail. "Considering how rapid is the natural increase of the dog," Darwin reflects, "it is difficult to understand the large price of all highly improved breeds, which almost implies long-continued close interbreeding, except on the belief that this process lessens fertility and increases liability to distemper and other diseases."

DATA FROM FOWLS.

Of the greatest importance for the question of inbreeding are, finally, the authorities gathered by Darwin relating to the breeding of fowls According to Sebright's statements his bantams became almost infertile through inbreeding, and the cocks, losing the secondary sexual characters, approached a female type; but the slightest degree of reversion to the proper male type—for example, the elongation of the two principal tail feathers by only half an inch, brought with it "an improved probability of increased fertility."

According to Wright's testimony Mr. Clark's fighting-cocks were so much affected by prolonged inbreeding that they allowed themselves to be knocked over without showing fight. Their weight decreased, to the great injury of their prize-winning power. Through a crossing with Mr. Leighton's stock,

they regained both weight and spirit. If the evils of inbreeding are overemphasized here, Ballance, the successful breeder of Malays, stands on another platform. Inbreeding does not necessarily involve the deterioration of the stock, he believes; "but all depends on how this is managed. My plan has been to keep about five or six distinct runs, and to rear about 200 or 300 chickens each year, and to select the best birds from each run for crossing. I thus secure sufficient crossing to prevent deterioration."

"With pigeons," says Darwin in conclusion, "breeders are unanimous that it is absolutely indispensable, notwithstanding the trouble and expense thus caused, occasionally to cross their much-prized birds with individuals of another strain, but belonging, of course, to the same variety. It deserves notice that, when size is one of the desired characters, as with pouters, the evil effects of close interbreeding are much sooner perceived than when small birds, such as short-faced tumblers, are valued. The extreme delicacy of the high fancy breeds, such as the tumblers and improved English carriers, is remarkable; they are liable to many diseases, and often die in the egg, or during the first moult; and their eggs have generally to be hatched under foster-mothers.

"Although these highly prized birds have invariably been subjected to much close interbreeding, yet their extreme delicacy of constitution can not perhaps be thus fully explained. Mr. Yarrell informed me that Sir J. Sebright continued closely interbreeding some owl-pigeons, until from their extreme sterility he as nearly as possible lost the whole family. Mr. Brent tried to raise a breed of trumpeters, by crossing a common pigeon, and recrossing the daughter, granddaughter, great-granddaughter and great-great-granddaughter with the same male trumpeter, until he obtained a bird with 15-16th of trumpeter's blood; but then the experiment failed; for 'breeding so close stopped reproduction'. The experienced Noumeister also asserts that the offspring from dove-cotes and various other breeds are 'generally very fertile and hardy birds'; so again, MM. Boitard and Corbié, after 45 years' experience, recommend persons to cross their breeds for amusement; for, if they fail to make interesting birds, they will succeed under an economical point of view, 'as it is found that mongrels are more fertile than pigeons of a pure race.'"

CONCLUSIONS WARRANTED.

I have here gone back to literal quotations from Darwin, because the views of this great naturalist, who was also an expert breeder, so exactly coincide with the general experience of practical men. I will freely admit that some of the evidence given in his examples is of damage done by inbreeding, and some of it merely of the results of pairing two animals which are not of first-class strength; the effects of bringing together two strains of weakness are thus mistaken for the effects of inbreeding. But if one admits that famous breeders thoroughly understand the necessity of breeding only from sound animals, then it must be admitted that these numerous examples prove that continued inbreeding *in itself* is injurious. As far as the practical production of farm animals goes, inbreeding does not offer itself as a desirable method; but this, however, is well understood. I might easily quote a great number of further instances from Darwin, which lead one to want to use caution in the practice of inbreeding. At the same time, however, I must say that in England the question has been illuminated just as it has for us, and it is absolutely wrong to believe, as we are so often told, that the English unconditionally advocate and practice inbreeding in their herds.

Things went the same way in France. If we examine Sanson, Baron, Magne, Cornevin and other important writers on the question of inbreeding, we find that here again views are decidedly diverse. Sanson[2] fully recognizes the potency of inbreeding, and the right places for its application, without sufficiently defining the different grades of close interbreeding. Baron takes a

[2]Sanson, Traité de Zootechnie, Paris, 1896.

slightly different view, pointing out that farmers finally get a glimpse of the fact that their animals are getting to be altogether too similar. Sexual differentiation gives place to a sort of neutrality, which may finally lead to sterility. Magne admits that it is very difficult to decide whether there is an actual power for evil in inbreeding as such, or whether any damage is wholly due to the union of two strains of weakness or the inheritance of a double dose of tendency to some disease. In practice, however, he advocates proceeding on the assumption that inbreeding does lead directly to injury. Cornevin alone, the most important of all, looks on inbreeding somewhat more leniently. And as he bases his views on a lot of first-hand observations, I will consider his views in a little more detail.

THE DEFINITIONS OF CORNEVIN.

Cornevin vigorously demands a distinction between the different grades of consanguinity. It makes a great deal of difference, he declares, whether one makes a "direct" pairing, "for example, father or grandfather, with daughter or granddaughter" or a "collateral" pairing (for example, uncle and niece). If inbreeding is held in so little esteem, it is because hasty generalization from single instances has been allowed to throw blame on all forms. The results of lateral pairing can not, in general, be compared with those of direct mating. Well, both now and in the past we have been accustomed to make the same distinction; only we were accustomed to speak more generally merely of "closer" or "wider" inbreeding; and today we have a measure for it, as has already been said, in the line of ancestors, or free generations. The plausibility of Cornevin's view can be proved by actual experimental breeding.

Next he alludes to the closeness and frequency of consanguineous marriages in antiquity, pointing out that these have not been wholly injurious. But against such a conclusion, drawn from human society, innumerable examples may be quoted, particularly where incestuous marriages were considered allowable. The Veddas of Ceylon, among whom marriage between brother and sister is said to be the rule, are really incapable of civilization, and also physically degenerate. As for the ancient Greeks, it is true that they permitted consanguineous marriages of very close degree, but we have no evidence as to the frequency of such unions with them. But after all: the results of close inbreeding often show themselves only after it has been continued a long time. Experiments in human society can certainly be quoted to throw light on the question of inbreeding, but not in the sense Cornevin understands.

HIS EXPERIMENTS.

Cornevin made limited experiments in inbreeding his own cattle, sheep and swine very closely. His Hollanders were inbred for 12, his Jerseys for seven years in this manner, without showing any evil results, and the prizes which the animals won each year at district shows certainly indicate that they did not present evidence of degeneracy. The *Merinos Châtillonais* had been inbred for 11 years at the time that Cornevin wrote his *Traité de Zootechnie générale* (1891) and were as little degenerated as the cattle. On the other hand, this ardent defender of inbreeding admits that it can not be practised with Yorkshire and Essex swine for more than two or three generations. These animals have such an inclination to lay on fat, that it leads to sterility and lack of milk on the part of the sows, when their tendency is accentuated by line-breeding. Indeed, adds Cornevin, the mere necessity of keeping them in a pen and feeding them highly became harmful, and it is questionable whether the result would not have been very different under more favorable circumstances.

Pigeons regularly multiply adelphogamically—that is, brother mates with sister; and so do swans, geese, guinea-fowl and ducks very often, according to Cornevin. He pursued inbreeding for 11 years with pigeons and geese, and there was no perceptible change of color, weight or fecundity. Guinea-fowls also showed no change, but Houdans and Crevecoeurs suddenly developed a strong

tendency to albinism. From experiments with rabbits it was decided that solid-colored animals with golden-brown hair, showing occasional spots of white, began to turn entirely white after the fourth generation. Cornevin therefore suddenly jumped to the conclusion that the effects of inbreeding differed with different animals, and that one could not dogmatically assert, for all species, that it was wholly harmless. He does not specifically state whether he was selecting the strongest animals to breed from, but his indorsement of inbreeding gives us good reason to believe that he was anxious, in his experiments, to keep the two factors carefully separated. He wanted to observe the results of inbreeding in itself—*par elle même*—and not to throw additional light on the well-known fact that an increased tendency to degeneracy may take place through the union of two tendencies to weakness and blemishes, when consanguineous matings are made.

MANY DIFFERENCES OF OPINION.

It is, accordingly, a mistake to think that only among us Germans is there such a diversity of opinion on the subject of inbreeding, and it is equally exaggeration to think that it is we alone who are so doctrinaire in these matters. In all civilized countries, the views on inbreeding and hybridization used to be based on the haps and mishaps of experiments and actual breeding. We have indeed carried on the controversy about pedigree-breeding and individual potency with the greatest keenness, and in the side-issues of this controversy inbreeding of course occupies a prominent place. But the heart of the question, whether inbreeding, in and by itself, results in evil, is warmly debated not only among us, but everywhere else. If our old theories about blooded stock were one-sided on that point, if they did not sufficiently distinguish between pure breeding and inbreeding, we can also reproach the individual-potency theory nowadays with very often being too general and disregarding the various aspects of the question, when it argues its conception of "crossing."

Buffon had published precepts that were—speaking as a breeder—simply crazy, but he did not lack followers. Hartmann, for example, supports him. "Never," he says, "must one give to a stallion mares of the same breed, nor must he permit the mating of two animals from the same stud. It cannot be too strongly recommended that one should endeavor as much as possible to cross his breeds of horses." Such views won the day, and they created a real danger. When experienced breeders, such as Wollstein, Ammon, Justinus, Mentzel, von Weckherlin, and others took a unanimous stand in sharp opposition, they performed a great service. But the too wide application of their own doctrines had a doubtful side. Though one might apply their principles, in an extensive practice of inbreeding, and secure satisfactory results, yet the laws underlying the whole question were not properly made clear, and the theorizers on pedigree-breeding did not even then get a full view of certain items which we now think must be considered in the technical application of the principles of inbreeding, if success is to be had or failure to be avoided. He who started in to practice the principles they laid down, often had to pay the consequences. And although von Weckherlin, thinking that the prejudice against inbreeding arose solely as the result of experience with sheep, questions whether these consequences are appreciable, the resultant careless practice of inbreeding was unfortunate.

IT WORKS BOTH WAYS.

Computations can indeed be made, that the practice led to fineness of wool, but the disease—the actual failure of many breeders—can also be traced very easily to the same practice. The widespread creation of definite herd-types through line-breeding has led to many damaging results in the sheep industry, and on general principles we ought to anticipate in all other branches of live stock breeding, that the building up of herds characterized by certain very definite traits would have a tendency to limit variation and thereby to destroy the prerequisite of evolutionary progress. Such a feeling has naturally

existed among breeders, so that from hoary antiquity to our own days it has always been recognized that one should attempt inbreeding only with the very best stock. Hermann von Nathusius has publicly expressed himself in a masterly manner "On Inbreeding or Pairing in Close Relationship."[3] As a reaction against much of the one-sided pedigree talk, his declarations had their place as an expression of the period, just as Hermann von Nathusius himself was a child of the period. Today he would express himself very differently on many points could he familiarize himself with the evidence as to the dangerous possibilites of inbreeding which has been acquired by many of the younger experimenters; but he is, unfortunately, no longer with us. All the more must it be recognized how objectively he expressed himself in his clear, simple and logical way, on the main point of our thesis, the evil results of inbreeding. As the Thoroughbred advocates dared to assume without qualification the position that aversion to consanguineous mating was not founded on natural considerations, but derived from moral ones and bolstered up by a false deduction from the evil effects of pairing diseased and blemished animals—then it was high time to state the facts in the case, in the form of general principles. For criticising these extremists and for pointing out the actual status of the question, Hermann von Nathusius is highly to be commended. But we of today must take with a grain of salt the ideas that he put in the form of five propositions, to end his discussion of the case:

1. The mating of closely related animals can result in good progeny; some of the best improved breeds have been built up by that method.

2. Up to date no indisputable example has been given of close family-breeding carried on among animals for even 30 years.

3. Among many of the most fortunate and exemplary breeds, in-and-in breeding has resulted in deviations from the standard.

4. Consanguineous breeding alone, therefore, can not be laid down as an adequate method of breeding.

5. On the other hand, it would be equally undesirable to abandon it bodily.

Had Hermann von Nathusius known the studies going on as to the origin of prominent breeds and herds, he would have qualified his first statement to say that not only some, but most, of the best breeds of improved live stock resulted from line-breeding. But indeed, he has expressed this idea more strongly elsewhere. And his last two propositions he would undoubtedly change, to the disadvantage of close interbreeding. For today we have learned through the studies of von Lehndorf, von Oettingen, de Chapeaurouge, Rau and younger writers, how important it is that a herd should have a widely-spreading pedigree. But I will not place this side of the question in the foreground just at this time.

Pusch, too, who was unhappily taken from us so prematurely, endeavored to show the dangers of inbreeding experimentally. More and more I am convinced that all trustworthy and properly controlled experiments in this direction lead us to the same conclusion: *Continued inbreeding always must result in weakened constitution, through its own influence.* The more we realize today that high transmissible performance seems to be bound to individual animals, and the more we endeavor to make use of the blood of these individuals through inbreeding, so much the more must we anxiously guard against deterioration of strength and shape. Otherwise we shall fall into the error made by the early enthusiasts for pedigree breeding, who by taking an unduly narrow view spoiled an idea which in and by itself was sound. Knowledge and experience will guide our great breeders in the right way. If, however, the idea that inbreeding is never harmful begins little by little, and in ever wider circles, to spread, then the evils which it involves must once more be adequately pointed out.

[3]Kleine Schriften und Fragmente über Viehzucht, Berlin, 1880.

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ALL BANANAS WERE ONCE LIKE THIS

Fruit of *Musa martretiana*, an African species, natural size. It consists of little but seeds. All bananas, before they were cultivated, must have been very much like this—their worthlessness has led O. F. Cook to suppose that the plant was first cultivated for the sake of its roots. Then, when sterile fruit, containing more pulp and only rudimentary seeds, was produced as a result of chance hybridization, primitive man must have seized upon such a fortunate result and perpetuated it by suckers. (Frontispiece).

See "Origin of the Banana," p. 273.

THE SCIENCE OF GENETICS

Too New to be Accurately Delimited—Represents an Empirical Study of Problems Which Have Been Treated Philosophically for Centuries—Its Importance to Agriculture—Its Application to the Improvement of the Human Stock.[1]

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THE science of genetics is so new that it is impossible to say at present just what it comprises and what its boundaries shall be. Until very recently, it did not even have a name, but the word "genetics", suggested by Professor William Bateson, has now been universally adopted. He says this word "sufficiently indicates that our labors are devoted to the elucidation of the phenomena of heredity and variation, in other words, to the physiology of descent, with implied bearing on the theoretical problems of the evolutionist and the systematist, and application to the practical problems of breeders, whether of animals or plants."

The science of genetics deals with evolution in all of its phases, as well as with the science and art of breeding. It makes contact with other sciences, especially biology, which lies at its foundation, as well as chemistry and sociology.

I think it may be truly said that in the development of the science of genetics our people, as human organisms, are more vitally concerned than in any other science. We look with great admiration, which becomes almost reverence, at the workers who are applying the physical and chemical sciences. But as great and wonderful as their achievements are, they do not necessarily concern all of the people.

Genetics, however, takes part in the life of every man, woman, or child, every plant or animal, in fact, every living thing. All organisms are the product of two forces acting together to determine what that individual shall be. Neither acts without the other and they are equally important. These are *environment* and *heredity*. Whatever we are or do, or whatever an animal or plant becomes, these two factors are constantly acting—the one, the external conditions surrounding us, the other the inherent constitution within us.

HEREDITY LONG OVERLOOKED.

Until very recently the factors which have received the greatest amount of study have been those of environment. We have looked upon plants and animals as controlled very largely by external forces, and even the study of man has centered around his environment, while the greatest force, heredity, has been largely overlooked.

The development of the study of this force has naturally been very slow, because it is more intangible, more subtle, more difficult to measure and determine accurately, than the more visible external conditions. The former cannot be measured in pounds, grams or degrees. It is impossible, furthermore, to draw a sharp line between heredity and environment and say exactly where one stops and the other begins. They are very closely linked together. To say which is more important in any organism requires very keen analysis and a history of the individual for many generations.

Nevertheless, problems of heredity and evolution have occupied the minds of men from the beginning, although any conclusions reached have been largely speculative and not based directly or indirectly upon experimental data. "It is true that until 1858, when

[1]Paper no. 44, Department of Plant Breeding, Cornell University, Ithaca, N. Y.

Darwin's Origin of Species was published, speculation far outran fact, and the development of the idea was at times arrested and even retrogressive. The Law of Evolution was reached not by any decided leap, but by the progressive development of every subordinate idea connected with it, until it was recognized as a whole by Lamarck, or later by Darwin."

Many evolutionary ideas trace back to Greek natural history literature, which from beginning to end is a continuous source of pleasure and surprise. Amid wide differences of opinion as to how far the Greeks actually anticipated later discoveries, the true conclusion is that they anticipated many of our modern theories by suggestion; thus they carried the idea of evolution well into its suggestive stage, which was so much ground gained for those who took it up in Europe. Greek speculations greatly hastened the final result, although judged by modern scientific standards they arose mainly as a series of happy conjectures.

As early as six hundred years before Christ, Anaximander wrote that the earth was, at first, a fluid. Gradually this fluid began to dry and grow thicker, and here and there dry land appeared. When this dry land had become firm enough to serve as his home, man came up from the water in the form of a fish. Slowly and gradually the fishes, struggling about on the land, gained for themselves the limbs and organs they needed for their new situation, and their development into men.

After them, other animals came up in much the same way, then the plants, until the whole world was clothed with its present inhabitants.

THE GENETICS OF EMPEDOCLES.

Empedocles, a century and a half later, added a new thought. He said that in the beginning there were all sorts of strange, incomplete, and misjointed monsters which swarmed upon the earth, having sprung up and out of the earth itself. Each was a chaos of limbs which were to belong afterward to other animals which needed them more. An interchanging came about slowly and gradually by which appropriate limbs fastened themselves to the proper animals. The last of these mis ointed creatures is the one known as the centaur, half man, half horse. After a while, when all of the members had found their proper places, the animals were complete.

Later came Anaxagoras, who was the first to believe that there was intelligent design back of the creation of animals and plants. He believed there had originally been a slime in which there was mixed, in a chaos, the germs of all the later plants, animals and minerals. Out of this mixture, order slowly arose by the minerals settling first, forming the earth, with the air floating over it and the ether above. The germs of plants settled out of the air upon the earth and vegetation covered the mineral floor. From the ether came the germs of animals and men.

The greatest scientific thinker of early Greece was Aristotle. He had spent his life by the seashore and knew better than any other man of his time the exquisite seaweeds and still more beautiful marine animals. He was the first to think of them as a related series, the higher developing out of the lower under the pressure of what is called a perfecting principle. Out of the inanimate rocks had sprung the marine plants—the seaweeds. From these had developed first "plant animals" like the sea-anemones and the sponges. These grew attached to the rocks, as plants do. With higher development came locomotion with ever increasing energy. At last man arose, the Crown of all Creation.

During the long middle ages, the evolutionary idea made no advance. Finally it began to retrogress, when Greek natural philosophy shared in the general suppression of the rationalistic movement of thought of Arabic origin. Later the hard and fast conceptions and definitions of species developed in the rapid rise of systematic botany and zoology, and were grafted upon the Mosaic account of the Creation, establishing a Special Creation theory for the origin of each species. Later still, when it was discovered in paleontology that species of different kinds had succeeded each other in time. the "special"

THE FIRST MUTATION ON RECORD

At the right is the Greater Celandine (*Chelidonium majus*) a plant of the poppy family found in Great Britian and throughout Europe. At the left is a "sport," or mutant form, markedly different in the shape of the leaves, which appeared in 1590. Such sudden changes or mutations in plants and animals have been widely studied since the declaration of De Vries, at the beginning of this century, that evolution was mainly due to them; and they are still the subject of continual debate among geneticists. Their origin is so mysterious that many biologists think they may be merely the effects of undiscovered hybridization in the ancestry of the plant producing them. All attempts to produce mutations experimentally have failed. (Fig. 1.)

theory was again remodeled to cover a succession of creations extending down almost to the present day.

After the middle ages, evolutionary theories were again revived, first by the natural philosophers and rashly speculative writers and finally by the working and observing naturalists. The climax was reached in the work of Lamarck and finally of that greatest of naturalists and philosophers, Charles Darwin.

THE INFLUENCE OF DARWIN.

The publication of the "Origin of Species" had a profound influence upon thought in all fields of human learning, but more especially in biology. The work of Darwin made such a deep impression upon biologists, in fact, that problems of evolution were considered to be settled for all time. For nearly thirty years inquiry into the methods of evolution was almost at a standstill.

This long silence was broken, however, in 1900, when Hugo De Vries, a Dutch botanist, published his monumental work, "Die Mutations Theorie." Many years before, it had seemed to De Vries that Darwin's hypothesis of the origin of species by natural selection and the gradual accumulation of variations was inadequate to explain all of the facts, and that the method of origin as postulated by Darwin was too slow to account for the origin of our present species within geological time. For the purpose of proving whether

this was true or not De Vries began a series of carefully planned experiments to demonstrate whether species may be produced experimentally. These tests and many subsequent observations demonstrated that species-formation is not always a slow and gradual process, but that new species may be formed at a single step.

These experiments have had great influence in stimulating research in genetics, not by the Darwinian method of collecting facts, but by carefully planned experiments with their proper checks. De Vries' reputation, indeed, will last longest not from his elaboration of the mutation theory, which was already suggested by Darwin, but by his introduction of the experimental method into the study of evolution. To the worker in practical genetics the experiments of De Vries also have great value. By dealing with vast numbers of plants or animals the breeder seeks to discover the mutants, as De Vries called the suddenly appearing new forms, or exceptional individuals, and produce new and valuable races from them.

PRESENT POSITION OF GENETICS.

The new science of genetics holds today a very prominent place among its sister sciences. Around it are clustered many great problems now occupying the attention of thoughtful men, while upon it is based the practice of the producer of animals or plants to bring forth better varieties and strains for the use of mankind. Problems of eugenics, furthermore, are receiving wide consideration, and in order to be sane and in accordance with the laws of Nature, they must be kept close to the foundation principles of genetics.

The laws of heredity were applied empirically by the shepherds of the flocks and the tillers of the fields centuries before their full import was known. Scientific and philosophic minds have long sought to solve the problems involved in the apparently simple truths, "like begets like", and "the sins of the fathers shall be visited upon the children unto the third and fourth generations." From the sum total of this knowledge, empirical and scientific, practical and theoretical, has been evolved much of definite significance concerning racial and individual development. But the most important and most attractive single contribution was the mathematical formula of heredity discovered by Gregor Mendel half a century ago. It is not exaggerated to speak of his discovery as leading into a new world, the very existence of which was unsuspected before.

"In research as in all business of exploration, the stirring times come when a fresh region is suddenly unlocked by the discovery of a new key. The conquest is easy and there are prizes for all. We are happy in that during our own time not a few of such territories have been revealed to the vision of mankind." "I do not dare to suggest," says Bateson, "that in magnitude or splendor the field of genetics may be compared with that now being disclosed to the physicist or the astronomer; for the glory of the celestial is one and the glory of the terrestrial is another. But I will say that for once, to the man of ordinary power who cannot venture into those heights beyond, Mendel's clue has shown a way into a realm of nature which for surprising novelty and adventure is hardly to be excelled."

To Gregor Mendel, monk and abbott, belongs the credit of founding the modern science of heredity. Through him there was brought into these problems an entirely new idea, a fresh conception of the nature of living things. Mendel demonstrated by a carefully planned series of experiments that plants and animals are not indivisible entities, but that every individual contains an enormously large number of smaller units, each separately heritable. And furthermore, he demonstrated that these units are transmitted in a definite and regular manner.

GREGOR MENDEL'S INFLUENCE.

The rediscovery of Mendel's Law some fourteen years ago has led to a complete change in our attitude towards the problems of variation, heredity and evolution; and the new method of study thus introduced has rendered possible a renewal of the attack upon these problems with renewed vigor and with remarkable results.

In systematizing any body of facts to form a science, it is first necessary to determine the underlying units out of which the facts are made up. Alchemy could not become chemistry until its fundamental units were discovered and identified. So the science of genetics could not exist until the conception was developed that the individual is made up of smaller heritable units called "unit characters." Thus we are concerned with the inheritance of unit characters and not with the individual as a whole. This gives us a method of analysis hitherto little employed in biology.

The observed phenomenon of variation is merely the manifestation of different combinations of these unit characters. Obviously, when individuals are made up of many unit characters, say five hundred to a thousand, the possible combinations of these units are almost limitless and thus there appears the variability which we observe.

The external manifestation of a plant or animal is, furthermore, little criterion of its actual genetic composition. Animals may be the same in appearance but differ widely in their offspring. Gray rabbits, for example, may be synthetically produced by bringing together a number of entirely different combinations of unit characters. Yet these gray rabbits look the same. Every organism has its peculiar formulae of body cells and germ cells, or as genetists say, its own genotypic and phenotypic formulae.

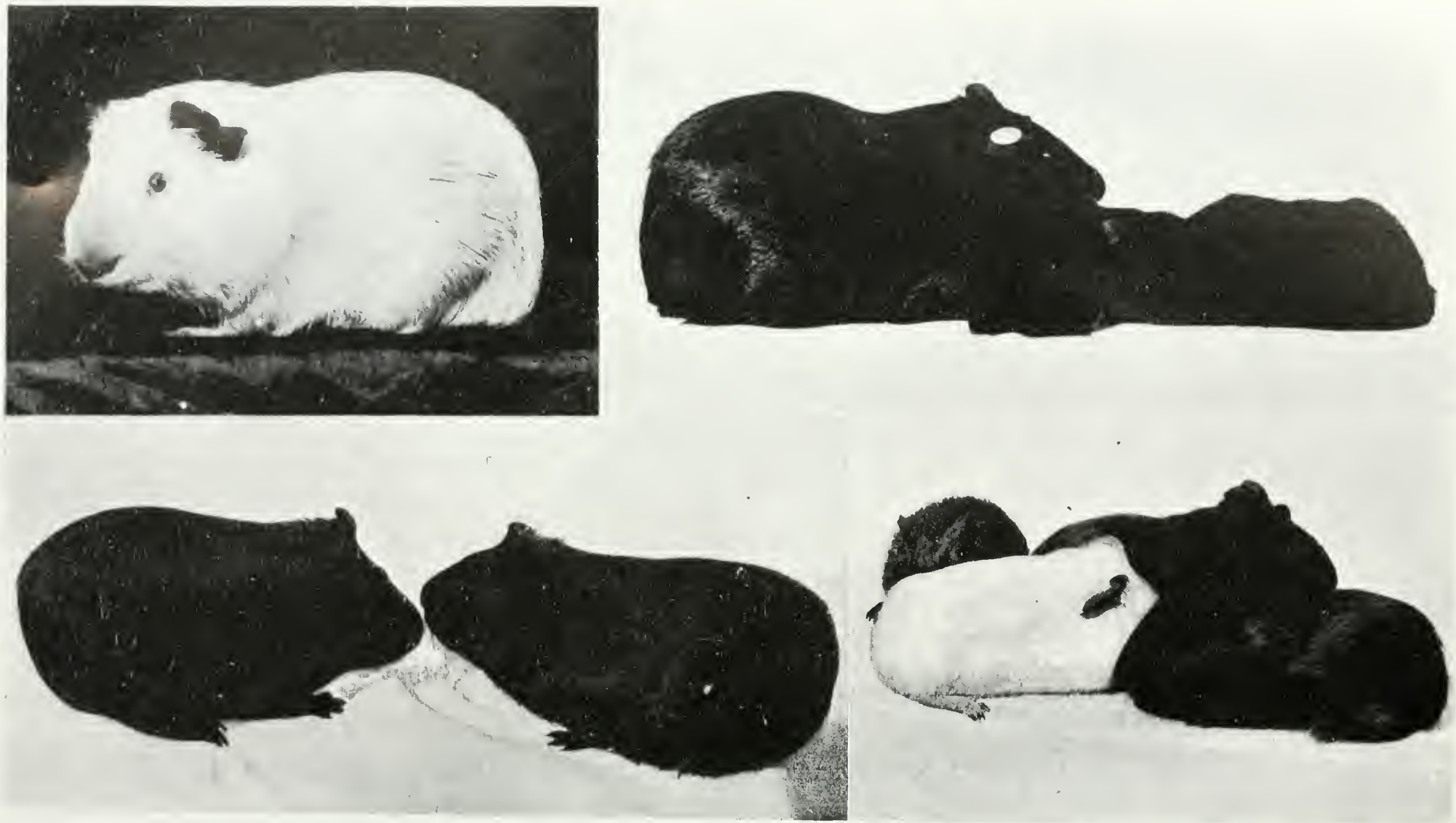
This principle was recognized many years ago by Jordan of France, who believed that species should be classified according to their method of transmission and not according to their external appearance. Thus we have the so-called "Jordan's Species."

THE QUESTION OF "PURE LINES."

Another problem which is puzzling the genetist at present is the theory of the pure line, projected by Johannsen. This deals with another phase of the unit character idea. If all organisms are made up of unit characters, these must exist as homogeneous combinations or heterogeneous ones. The offspring of a self-fertilized plant having similar unit characters is called a "pure line." According to this theory, the process of selection as we ordinarily consider it is a process of isolating pure lines. When this is done, according to Johannsen, no further progress in changing the race is possible unless a mutation or the sudden manifestation of a new unit-character appears. According to this notion, selection is a process of isolation and elimination and has no power to cause advancement. This leads us to consider another and greater problem, perhaps the greatest of all—the cause of variation and mutation.

If evolution takes place by the appearance of new unit characters or mutations—where do these come from? and can they be controlled? This is the eternal mystery. Experiments give us little clue. Many experimental attempts have been made to produce mutations but all have failed. All apparent successes have turned out to be illusory, when subjected to rigid tests. Most have proved to be not new characters at all, but merely new combinations of old ones. Of course, we can produce such new combinations, in many cases, at will, but that is a far different thing from actually producing a new character. At present, our only means for getting a new character is to sit down and wait until it appears—whence or how we know not. Even when it has appeared in this way, it is quite as likely to disappear again, if it proves disadvantageous to the individual carrying it. In such an event natural selection eliminates it (by destroying the individual carrying it)—unless it should happen to be useful to man. In the latter case, we artificially preserve it by removing the individual carrying it from competition with its wild relatives, and putting it to our own use. That is why domesticated races of animals or plants differ from their wild relatives.

One of the greatest problems, even yet, before the student of genetics is that much discussed subject, the inheritance of acquired characters. Are the qualities which an organism receives during its lifetime passed on to its offspring? If so, by what mechanism is



THE SIMPLEST EXPRESSION OF MENDEL'S LAW

The Austrian monk, Gregor Mendel, was the first man to express the laws of heredity as mathematical formulae, a method which geneticists are now attempting to apply in every possible field. Such formulae can be developed only as a result of experiments on a large scale, which in Mendel's case were conducted with garden peas. Another application of the simplest of his formulae is shown in these photographs of guinea pigs bred by W. E. Castle. The character "black" is *dominant* to the character "white," which is therefore called *recessive*. When a white and black guinea pig are bred together (upper left and right) all the offspring will be black. If the members of this (first filial or F1) generation are bred together (lower left), however, it is found that *segregation* of the characters takes place in the second filial (F2) generation, according to the mathematical laws of chance, so that in the F2 generation the proportion of black to white individuals is 3:1. Further breeding shows the white animal to be pure for that character, and one of the blacks to be pure; the other two blacks (in general terms 50% of the F2 generation) are found to have white as well as black in their germ-cells, and bred together will again give the 3:1 ratio. (Fig. 2.)

this done? These are the ever-present questions which have been worn threadbare by biologists and evolutionists who have based their so-called arguments upon philosophical speculations and have not arrived at these conclusions as the result of experimentation. The present tendency of genetics, however, is to base its conclusions upon the results of controlled experimentation only, and the empirical method is being applied to this time-honored controversy with the hope of obtaining something tangible and definite.

To prove experimentally the inheritance of acquired characters, suggests Walter, three things are necessary: first, a particular variation must be called forth by a known external cause; second, it must be something new and not merely the awakening of latent qualities; and third, this induced variation must exist and reappear in subsequent generations after the original exciting cause has been removed. Up to the present the so-called "acquired characters" which seem to be inherited have failed to fulfill all of the requirements.

COMMERCIAL VALUE OF GENETICS.

The thrill of discovery is not dulled by a suspicion that the discovery can be commercially applied. "With rarest exception the discoveries which have formed the basis of physical progress have been made without any thought but for the gratification of curiosity. Of this there are few examples more conspicuous than the work of Gregor Mendel. Untroubled by any itch to make potatoes larger or bread cheaper, he set himself in the quiet of a cloister garden to find out the laws of hybridity, and so struck a mine of truth, inexhaustible in brilliancy and profit."

Nevertheless, the work of Mendel had very great practical application. The discovery known as Mendel's Law enables the breeder, if given sufficient time, to construct an animal or plant almost at will. He can take a bit here and a bit there and by hybridization unite them to produce whatever is desired. For example, suppose there is desired on the market a plant with a red flower, dwarf stature and smooth leaves. A breeder goes about the production of this plant by taking a variety containing the red color and another variety having the dwarf stature and crossing them together. When the hybrid is produced, he crosses that with a third parent having smooth leaves. As a result, he will have brought together in some one of the offspring all of the qualities desired.

You will see that the claims put forth by students of genetics are high, but I hope to be able to show you that their claims are not unfounded. Any body of science has immediately an added fascination when its supporters are aware that their labors are somewhat in the main stream of progress. The science of genetics can boast of this position.

With an understanding of the facts of transmission of plant characters from generation to generation, we are enabled to control the forces of heredity almost at will. Biologists are learning how to harness and use heredity as electricians are learning how to harness and use electricity. The one uses the great network of heredity by taking a bit here and a bit there and putting them together, creating a valuable new plant or animal, the other takes our waterfalls which have little use and converts them into greater sources of power for the benefit of mankind.

Hays says, "It is fair to estimate that, of the twenty-seven billion dollars of our annual national production, electricity and breeding may each be credited with one billion dollars. It is also reasonable to expect that each will have added another billion annually by the time our total production reaches thirty-seven billion dollars. As countless waterfalls along our streams are waiting for the electrical engineer to bring them into service of man, so the choicest blood streams of heredity in the various species of plants and of animals are waiting for the plant breeder or the animal breeder to segregate them and make them available."

Scientific breeders believe that every species is amenable to improvement by breeding; that every species has in it individuals with rare value for producing progeny along desired lines. Breed-

ing power, projected efficiency, or the power of the individual plant or animal to beget valuable progeny, has come forward as a central idea in plant and animal breeding. Careful breeders are searching each species for the occasional, the phenomenal individual—when that one in many thousands is found, all the rest are discarded. This individual of superior blood is then multiplied and sent to the growers to take the place of their half-civilized kinds, and thus these varieties are superseded by the improved kind. This is the method of improving plants and animals by simple selection.

Breeders have worked out a yet more radical method of producing improved varieties, the method of crossing or hybridization, followed by selection. Once those rare forms with heredity strongest in the lines in which improvement is desired are secured, new and more pronounced varieties are created by bringing together from widely separated sources, those of the same variety, and crossing or hybridizing them. The resulting progeny diverge, or vary, more widely than the progeny of forms more closely related. The exceptional individuals among these are searched out and tested, in the hope of securing an unusual or phenomenal individual of much stronger breeding ability than any found in either of the stocks used as parents of the cross. Thus is created an occasional plant or animal which combines the best in each parent stock and has the rare power of projecting this new combination of values into its progeny. To illustrate, Dr. William Saunders, of Canada, by crossing the two varieties of wheat known as Fife and Lagoda, produced Preston wheat, more valuable than either of its parents; Webber and Swingle, by crossing the sweet oranges with their wild relatives, produced valuable new species called citranges and tangelos; and Burbank, by hybridizing the black walnut and the English walnut produced hybrid walnuts of great value.

CHANCE FOR PRACTICAL MAN.

In the case of numerous species of plants, as wheat, flax, carnations and sugar beets, scientific breeders have already devised effective plans for ferreting out individuals with rare breeding ability along desired lines, and for thus creating new types or improving existing forms by using the subtle forces of heredity.

Such results are not beyond the practical breeder, as the history of countless varieties attests. In the middle of the last century, in France, Louis Vilmorin set out to increase the value of field beets as a forage crop. With strong faith in the unity of Nature, and the underlying principles of organic development, he seized upon some of the methods already in use in the production of blooded live stock, and adapted them to the production of "blooded" beets. This was a great departure in plant-breeding, and this method, elaborated and adapted by modern breeders, is one of fundamental importance in the creation of new types or the improvement of existing forms of life. Vilmorin's work with beets resulted in raising the sugar content of the sap from seven per cent. to 15 per cent. This change in the heredity of an humble plant was the basis of a new industry in France and in other European countries—the beet-sugar industry—and one which has now become thoroughly established in this country. The potency of that subtle character in Vilmorin's selected beet plants, chosen for their peculiar power to increase the sugar in the sap of their progeny, has added millions to the wealth of the world.

There is no lack of utility and direct application in the study of genetics. If we want to raise mangels that will not run to seed, or to produce a cow that will give more milk in less time, or milk with more butter and less water, we can turn to genetics with every hope that something can be done in these directions.

But the science of genetics is concerned with another field to which I have but briefly alluded—the field of eugenics, the improvement of the human stock. Eugenics is the application, to the human race, of the principles about which I have been speaking. This subject will be so well covered in the

Journal by experts better qualified than I, that I will say nothing more than to quote a few sentences from Professor Bateson. He says, "But here I would plead what I cannot but regard as a higher usefulness in our work. Genetic inquiry aims at providing knowledge that may bring certainty into a region of human affairs and conceptions which might have been supposed reserved for ages to be the domain of the visionary. We have long known that it was believed by some that our powers and conduct were dependent on our physical composition and that other schools have maintained that nurture, not nature, to use Galton's anthithesis had a preponderating influence on our careers; but as soon as it becomes common knowledge—not a philosophical speculation, but a certainty—that liability to a disease, or the power of resisting its attacks, addiction to a particular vice, or to superstition, is due to the presence or absence of a specific ingredient, and finally, that these characteristics are transmitted to the offspring according to definite, predicable rules, then man's view of his own nature, his conceptions of justice, in short his whole outlook on the world, must be profoundly changed. Yet as regards the more tangible of these physical and mental characteristics there can be little doubt that before many years have passed the laws of transmission will be expressible in simple formulae."

Two Contributions to Eugenics

The need which has long been recognized for compilation of the sources available for students of eugenics, is gradually being met. A. Edward Hamilton of the Extension Department, Eugenics Record Office, has published a paper in the Pedagogical Seminary, Vol. XXI, pp. 28-61 (March, 1914), in which he lists 100 of the most important works which have appeared, and precedes them with a full commentary, on chronological lines, which makes an excellent history of the progress of the science. The demand for a more complete bibliography has been largely satisfied by the publication of a bulletin of 131 pages by the State Board of Charities of New York, through its Bureau of Analysis and Investigation, in charge of Dr. Gertrude E. Hall. This Bibliography (Bulletin No. III, November, 1913) covers "Eugenics and Social Welfare," and is reasonably complete from a genetics point of view, while its cacogenics references are remarkably full.

German Progress in Genetics

An institution for the experimental study of heredity (Institut für Vererbungsforschung), the first of its kind in Germany, will be established in the next summer semester at the Royal Agricultural High School in Berlin. The Institute, which is divided into a zoological and a botanical section, comprises three acres of ground for experimental breeding, a row of greenhouses, and a building for laboratories. It will be built up on the remaining land of the High School in Potsdam during the course of the next year. Professor E. Baur, Ph.D., M.D., hitherto director of the Botanical Institute of the Royal Agricultural College, Berlin, has taken the direction of the new institution, while the zoological department will probably be entrusted to Dr. B. Klatt, *privatdozent* of the high school.—Mitt. der Deutsch. Landwirthsch. Ges.

COAT COLOR IN POINTER DOGS

Examination of Stud Book From Mendelian Viewpoint Suggests That Relation of Brown to Black is the Same in Dogs as in Other Small Mammals Which Have Been Investigated, and That There are Two Types of Yellow—Practical Breeding Rules.

C. C. Little

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THE time and expense necessary to conduct, on any considerable scale, a series of breeding experiments with pedigreed dogs, has led to few efforts to investigate the laws of inheritance in their case. The work done by geneticists with other small mammals has, however, shown that if Mendel's Law can be used successfully in the breeding of dogs, a large number of new and interesting forms might well be produced.

Since the actual breeding experiments with dogs are not likely to be undertaken for some time, the question naturally arises as to whether it is possible to obtain from already existing data any information which would be of use to the scientific breeder.

Knowing that the American Kennel Club has for years registered and recorded pedigreed and full-blooded dogs of almost every recognized breed, I obtained their stud book (Vols. 11-29 inclusive) to ascertain whether or not they contained available data on color inheritance. I found that in nearly every animal color was recorded, and that in several breeds the colors were simple and distinct enough to serve as fair material for tabulation. As E. N. Wentworth has recently pointed out in this journal, it is advisable to avoid, in so far as possible, stud book records which would be apt to be distorted as a result of favoritism to one color at the expense of one or more others.

After some hesitation, with this fact in mind, I chose pointers as a breed combining the greatest number of advantageous points with a minimum of disadvantageous ones. Some of the points may now be considered in detail.

ADVANTAGES OF THE MATERIAL.

First: The colors of pointers are distinct, being black, brown (liver), and yellow (lemon, orange or tan), on a white ground. Between these three colors—black, brown and yellow—there is little or no chance of confusion.

Second: The pointer is a well-established breed supposed to have been imported to England from Spain early in the eighteenth century, and then to have been crossed with the "brach" or the foxhound. From this cross the modern pointer is supposed to have been evolved by a process of inbreeding and selection. On the authority of Shields, a French encyclopedia, in defining the "brach" or "braque," states that it possessed the spotted coat, short hair and colors of the modern pointer; facts of considerable importance and evidence in favor of the braque as one of the ancestors of the pointer.

Third: No one of the colors is desired for breeding or showing to the exclusion of the others. Of course there are doubtless local preferences for one or the other color and these are probably well marked, but for the most part it can be said that pointers are as free from such preferences or prejudices as any other breed. It is at least sufficiently free from them to assure the absence of any wilful deceit in describing the color of any one animal. Lee, Compton and Westbrook all state that at the present time liver is the most popular color, then comes yellow next in favor, and

then black. That such is the case the relative proportions of the three records in the stud book seems to show.

STUD BOOK STATISTICS.

Stud book statistics are all of them open to the objection that, at their best, they represent part of the truth rather than the whole truth, in that the animals recorded are not the total count of offspring produced by any mating, but are rather those that reach saleable age or maturity and are reasonably close to the standard of the breed to which they belong. Such circumstances bring about a somewhat distorted view of the actual phenomena of inheritance in this case, but if proper allowance is made for probable inaccuracies it seems likely that stud book records of a standard organization like the American Kennel Club are accurate enough to give valuable statistics.

In collecting the data for this paper certain points had to be considered. Each mating of registered dogs was recorded on a separate card and filed according to the dam's registration number. On this card the offspring of the mating were recorded one by one as they were met with. No mating was used in compiling results unless it contained two or more offspring. Fully two-fifths of the pointers listed in the American Kennel Club stud book are from unregistered parents. None of these matings were recorded, since they were less valuable and less accurate in nature than those of registered parents. The earliest volumes of the stud book (Vols. 1-10) were not accessible to me from the same source as the later ones. This is not of any great importance, however, since the number of animals included in them is not large and since the chance of technical errors is undoubtedly greater in the earlier numbers than in the later ones.

LANG'S WORK WITH DOGS.

One of the few investigators to publish work on inheritance of dogs since the rediscovery of Mendel's Law is Professor A. Lang. Lang experimented with a pair of F1 hybrid dogs which he obtained through Herr Pfister-Kupfer.

The dogs thus obtained by Lang were black in color, and had been produced by crossing a brown-spotted female, somewhat hound-like in appearance, with a pure-bred black Newfoundland male. Fourteen puppies were thus produced, all of which were black in color. This is excellent evidence that black is epistatic to brown, thus coinciding with the work of many investigators of inheritance in mice, rabbits and guinea-pigs.

Lang wished to inbreed the F1 animals in order to ascertain whether or not alternative inheritance existed. If such was the case, brown puppies would reappear in the F2 generation. He therefore mated together his two F1 animals and obtained a litter of eight puppies. Of these, five were black and three brown, six to two being the theoretical Mendelian ratio in this case. This shows that in all probability, black and brown, in dogs, will follow the same order in inheritance that they do in mice and guinea-pigs.

A careful record of the extent of pigmentation also revealed that solid and spotted coat were, in all probability, a pair of Mendelizing units as they are in the other small mammals already investigated.

OBSERVED FACTS IN POINTERS.

If one turns to the case of pointers as recorded in the stud books, one finds this same pair of characters, black and brown, showing the same relation to each other. In pointers, as in most hounds and spaniels, brown is often spoken of as "liver." The brown or liver-colored dog is very distinct from black or any of its modifications, such as blue or gray. The nose and feet of the liver-colored dog are pigmented with rich chocolate brown pigment, with no trace of black pigment present.[1]

It is well known to breeders of dogs that yellows are of two very different types. This holds true in the case of pointers. One type is a bright, vivid yellow with *dark eyes and black nose.* The other type is duller and often lighter yellow *with pinkish-brown nose and light eyes.* The latter are considered inferior in many breeds and are, therefore, seldom

[1]In the table and test following, liver is used interchangeably with brown.

used for breeding purposes if it is possible to avoid them. The significance of these two types of yellow is already known in the case of rabbits and guinea-pigs and will, I believe, become apparent to all who breed dogs with an eye to testing the validity of Mendel's Law of heredity.

If we now turn to the tabulation of the matings of pointers from the American Kennel Club stud books, the following results are obtained:

Nature of Mating	Number of Matings	Color of Offspring		
		Black	Yellow	Liver
Liver x Liver	97	0	21	305
Black x Black	8	23	0	5
Yellow x Yellow	1	0	4	0
Black x Liver	56	77	9	95
Yellow x Liver	15	8	10	46
Yellow x Black	9	6	10	2
Totals	186	114	54	453

From an examination of this table it will be seen that liver appears to be hypostatic to black, and yellow, in turn, hypostatic to liver. We know, however, that there are two visibly different types of yellows and this, together with the facts stated above, suggests the hypothesis that we are here dealing with two pairs of Mendelian factors. These factors we may designate as:

B: The factor for black pigment which is absent from brown (liver) animals.

E: The factor for extension of brown and black pigment in the hair. In the presence of this factor, animals have spots of brown or black pigment on a white ground; in its absence the colored spots on the coat are yellow of various shades.

The table given above shows that black crossed with black produces occasionally brown young. On the other hand, brown crossed *inter se* give no black offspring in a total of over 300 young. This last mentioned type of mating does, however, produce some yellow young as well as brown ones. These facts seem to justify the conclusions as to the relative position of the various factors involved.

Hagedoorn has stated that, in the case of dachshunde, yellow is epistatic to black, that is to say that restriction of brown and black pigment is dominant over the extension of these pigments. This is a point of very great interest, for if carefully executed experiments could be carried out we should have a chance to investigate the behavior of a dominant and of a recessive yellow in forms that were perfectly fertile when crossed. This would afford an opportunity to obtain data of great importance on a point of considerable theoretical interest in genetics.

To return to the case of pointers, we should then expect to find the four following visibly different zygotic types.

1. BE—Black;
2. bE—Brown (liver);
3. Be—Yellow (black nose);
4. be—Yellow (brown nose).

We may now consider in detail certain matings which indicate the existence of these four types.

SOME INTERESTING MATINGS.

Type 1—Black. That black is of this constitution is shown first by the black x black matings (see table) which produce liver young; and second, by the fact that black by liver may produce yellow young. The appearance of these two hypostatic forms in crosses in which at least one parent is black, and the fact that no black animals are formed as the result of mating liver x liver or, yellow x yellow, show that blacks possess factors which both yellows and livers lack.

Type 2—Brown. That these animals lack the factor B is shown by the fact

that they have not the ability to produce blacks when mated *inter se*; while the formation of yellows in liver by liver matings shows that liver animals may possess the factor E in half or all their gametes.

Types 3 and 4—Yellow. The distinctness of these two types of yellow is seen by the following matings:

Female 40471 yellow was crossed with male 47940 liver. It is known from the 97 matings of liver-colored animals that no liver-colored animal can carry the factor for black. If this mating produced any black young, therefore, it would be certain that it was the yellow parent; in this case female 40741 that carried the factor for black. The actual result was seven brown, five yellow, and *six black young*. The yellow parent was accordingly of the formula Be.

The other type of yellow is seen in a mating between female 46990 yellow and male 54357 brown, which gave only brown (liver) young, eight in number. Here the yellow parent was of the formula *be*.

In the case of certain animals it is possible to form a more or less definite idea of their gametic constitution. Thus, for example, male 41525, black, is undoubtedly BbEe in formula. When crossed with females of formula bbEE (homozygous liver), he has sired 10 black and 16 liver-colored puppies, the Mendelian expectation being equal numbers of these two colors. When crossed with yellow females he has sired four yellow and six non-yellow young, equality being again expected. When crossed with liver-colored females heterozygous in E (formula bbEe), he has sired eight blacks, two browns and three yellows. In this case a 9:3:4 ratio is expected.

Another famous sire, 40708 black, is probably of the formula BbEE. Thus, when crossed with brown females, he has sired 17 black and nine brown young; 13 black to 13 brown being the theoretical proportions. When crossed with a yellow female he has given a total of seven young, all non-yellow in character.

IMPORTANT PRACTICAL POINTS.

Several points of importance to the practical breeder now became apparent. In order to purify a strain from black individuals it is only necessary to go on breeding liver to liver and yellow to yellow indefinitely. As long as this is carefully done there should be no blacks produced. Yellows from two liver parents may safely be crossed with liver-colored animals. If, however, any other yellows are used, the breeder may expect a certain number of black young among the progeny. To obtain a pure black strain is not so simple, requiring for its certain completion a separate breeding test for each black individual by crossing it with yellows coming from two liver parents. If among the progeny any liver or yellow young are found, it is certain that the black in question is not of the formula BBEE, and will, therefore, not breed true. Among the liver animals there should theoretically be found two types; one homozygous for the factor E and one heterozygous for this factor. The former type should in crosses with yellows produce only non-yellow young. To this class belong the following liver animals, 54357, 52793 and 47456, which have produced by yellow mates, eight, six and five liver-colored young respectively. The other type of liver animal carrying yellow as a recessive, is seen in such animals as 44135 and 41348. These animals when mated to yellows have produced a total of three liver and two yellow young, the Mendelian expectation being equal numbers.

Before considering the data in this paper as conclusive, breeding experiments should be made. The writer believes, however, that the data is worthy of publication, since it hints strongly that the methods of color breeding, used so successfully in the case of the smaller mammals, may be of value in breeding dogs. It also shows that the stud books of the American Kennel Club may be used as a source of information as to color inheritance in the case of several breeds of dogs. In addition it shows tentatively that there is a recessive type of yellow dog, analogous to the recessive yellow of guinea-pigs; and that the relation of brown to black is the same in dogs as in the other small mammals in which the matter has been experimentally investigated.

In closing I. wish to express my indebtedness to my father, James L. Little, for the chance to use the American Kennel Club stud books, and to my wife, Katharine D. Little, for her assistance in collecting the data and in preparing the paper for press.

REFERENCE CITED

CASTLE, W. E. (1909) Studies of Inheritance in Rabbits. Carnegie Inst. of Wash. Publ. No. 114, 68 pp.

COMPTON, H. (1904) The Twentieth Century Dog. Vol. 2, Grant Richards London. 456 pp.

HAGEDOORN, A. L. (1912) On Tri-Color Coat in Dogs and Guineapigs. Am. Nat. Vol. 46, pp. 682-683.

LANG, A. (1910) Uber Alternative Vererbung bei Hunden. Zeit. fur Indkt. Abst. u. Vererb. Bd. 3, pp. 1-32.

LEE, R. B. (1893) A History and Description of the Modern Dogs of Great Britain and Ireland. Horace Cox, London, 584 pp.

WENTWORTH, E. N. (1913) Color in Shorthorn Cattle. Am. Breeders Mag. Vol. 4, pp. 202-208.

WESTBROOK, C. K. (1891) American Book of the Dog. Rand McNally Co. 702 pp.

Eugenics Program in Utah

Dr. Frank M. Driggs, superintendent of the Utah School for Deaf and Blind. was elected president of the Utah Eugenics Society, at its annual meeting in Salt Lake City during April. The following papers were read: Eugenics and the Nation, by Mathonihah Thomas; Eugenics and the Profession, by Dr. J. Edward Day; Popular Misconceptions of Eugenics, by Dr. Joseph Peterson; Menace of Social Diseases, by Dr. W. R. Tyndale; Reforms Eugenics Can Not Accomplish, by Dr. E. G. Peterson; Eugenics and Legislation, by J. C. Wheelon; Education for Parenthood, by Dr. Ada E. Faust. The secretary, Dr. E. G. Titus, of the University of Utah, writes:

"The general trend of the discussions was all to the effect that we are not ready for many of the odd and peculiar bills which have created enthsiasm in several of the states. That is, it is much better at the present time to devote our energies to education along eugenics lines, endeavoring to reach all the people possible and give them an idea of what we consider a proper trend of eugenics; to have all the lectures possible delivered before schools, church organizations and other general assemblies; to endeavor to secure cooperation of libraries in order that they may introduce eugenics books; to secure the cooperation of the various woman's clubs especially those belonging to the Utah Federation of Woman's Clubs, and if possible, to secure at least one place on the program of each club for the coming year; to endeavor to secure better care and protection for the classes of people who are unable to properly care for themselves."

Benefits of Eugenics

The effects of eugenic reform, if successful, would be to lower taxation, to raise real wages, to facilitate commercial competition, and to increase the security of the country in time of war. In things wholly immaterial, great benefits would moreover be felt; for a diminution in the number of the insane, the feebleminded, the criminal, and the wastrels annually brought into the world would mean the removal of a terrible burden of unmerited misery; whilst an increase in the output of men and women of character and ability would not only add to the reputation of our country, but would also add to its happiness in many ways. These are the benefits we hold to be in the power of this generation to bestow on our country in the future by now resolutely grappling with the problem of human heredity.—Extract from presidential address (1913) of Major Leonard Darwin before the Eugenics Education Society, London.

FACES AND RACES

Vernon L. Kellogg
Stanford University, California.

THE Mid-Pacific Institute of Honolulu is the result of the amalgamation in 1910 of several boarding and mission schools for boys and girls. Oldest of its included schools is the Kawaiahao Seminary, primarily intended for the education of Hawaiian young women and girls. It was founded in 1846 and has a record of much effective and beneficial work. But its pupils are by no means all Hawaiian although they are all, for the moment, of Hawaii. This is strikingly shown by the photograph, reproduced herewith, of 26 of the 127 girls now in the Seminary.

This interesting photograph, which was made by Miss Roselle F. Faast, one of the teachers in the school, is rendered accessible to the readers of the Journal of Heredity by the kindness of E. M. Ehrhorn, entomological superintendent of the Hawaiian Board of Agriculture, who sent it to me recently with the data of the races and race mixtures represented by the faces pictured in it.

The grouping for the photograph was made by Miss Faast for the sake of picturing the extraordinary melange of races represented in the school, and includes, with one exception, all of the pure and mixed race types occurring in it. It reveals, therefore, the extraordinary conditions in a school under the American flag in which every fifth student is of different race or race mixture. More than that, some of these mixtures are of most unusual character, as Irish-Chinese-Hawaiian, and Alaskan Indian-Japanese-Hawaiian, and Guam-French-Mexican.

The faces in the photograph are so clear, and the racial traits so well shown, that its careful study under a reading glass (granted that it does not lose too much of its sharpness of definition in the process of reproduction) will enable any interested reader to determine for himself, in some measure, the dominating characteristics in these results of certain experimental human hybridizations.

The distribution of the parentage of numbers 16, 17, 23 and 25, which are given in the caption of the illustration as including three races each, is as follows:

No. 16: Father, half Alaskan Indian, half Hawaiian; mother, half Japanese, half Hawaiian.

No. 17: Father half Portuguese and half Hawaiian; mother, half French and half Hawaiian.

No. 23: Father, pure Guam; mother, half Chinese and half Hawaiian.

No. 25: Father, Irish; mother, half Chinese and half Hawaiian.

A POLYNESIAN-NORWEGIAN METISSE

The Editor.

THE behavior of the Polynesian stock, when crossed with a Germanic one, is more plainly shown in the accompanying photograph by Miss Faast of a girl of South Sea (Nauru)-Norwegian ancestry, who is also included in the group picture (No. 15).

The Polynesian race, which is widely scattered over the South Pacific, is a comparatively late arrival, having spread throughout the islands in successive migrations since the Christian era, and up to historic times—the largest of these waves may have taken rise in the fifth century. It is now

KEY TO PHOTOGRAPH ON OPPOSITE PAGE

Twenty-six of the 127 girls in Kawaiahao Seminary at Honolulu, T. H., each of a different race. One other mixture which might have been included —English-Hawaiian—was inadvertently omitted from the group. The racial stocks of the girls here shown are as follows:

1. Korean.
2. Spanish–Hawaiian.
3. Norwegian–Hawaiian.
4. Scotch–Hawaiian.
5. American.
6. German–Hawaiian.
7. Chinese–Portuguese.
8. Chinese.
9. Hawaiian.
10. Porto Rican–Spanish.
11. German.
12. Filipino.
13. Chinese–Hawaiian.
14. Spanish-Portuguese.
15. South Sea (Nauru)–Norwegian.
16. Japanese–Alaskan Indian–Hawaiian.
17. French–Hawaiian–Portuguese.
18. Japanese.
19. Swedish–Hawaiian.
20. American–Hawaiian.
21. Portuguese–Hawaiian.
22. Filipino–Portuguese.
23. Guam–Mexican–French.
24. Irish–Hawaiian.
25. Irish–Chinese–Hawaiian.
26. Portuguese.

Fig. 3

NORWEGIAN-POLYNESIAN GIRL

Unions between European men and native women are common in the South Seas, and according to the missionary, George Brown, they are, in Samoa at least, more fertile than those between natives. The offspring is characterized by exceptional vigor, in accordance with the law of hybridizing so familiar to those who work with plants and animals; there seems to be insufficient evidence as to the value of succeeding generations. The cross in this case is not a very "wide" one, according to De Quatrefages' analysis of the Polynesian race, but it appears that most of the noticeable Polynesian traits are dominant over those of the Norwegian father. (Fig. 4.)

pretty generally agreed that the race is of Malayan origin, although it reveals traces of other strains of blood, not now found in the Malay archipelago.

"This is evident in their physical appearance", says Daniel G. Brinton, in "Races and Peoples." "They are uncommonly tall, symmetrical and handsome, a stature over six feet not being unusual among them. Their features are regular, their color a light brown. Their hair is black, smooth and glossy, sometimes with a crisp or curl in it, which betrays a touch of Papuan blood."

This Papuan blood was probably gained while the race inhabited the small island of Buru or Boru, between

Celebes and Papua, where the emigrants lived for a time after leaving their home in the western group of islands, according to Brinton. "Leaving Boru, they passed to the North of New Guinea (Papua), colonizing the Caroline and Solomon Islands, but their vanguard pressing forward to take possession of Savai in the Samoan group and Tonga to its south. These two islands formed a second center of distribution over the western Pacific. The Maoris of New Zealand moved from Tonga—'holy Tonga' as they call it in their songs—about 600 years ago. The Society Islanders migrated from Savai, and they in turn sent forth the population of the Marquesas, the Sandwich (Hawaiian) islands, and Easter Island."

ULTIMATE ORIGIN OF RACE.

As to the ultimate origin of the race, before its residence in the Malay archipelago, many hypotheses have been put forward, and there is scarcely data available, it seems, to raise any of these above the level of a hypothesis. On the basis of a supposed large Semitic element in the Polynesian language, it has been alleged that they came from Arabia; the most generally received opinion, however, is probably one which places their first home in south-eastern Asia.

The French anthropologist, De Quatrefages, held that the Polynesians were essentially a hybrid race, and sustained his thesis as follows:[1]

"Everything indicates that the Polynesian race is a mixed race, that is, that it has been formed by means of crosses between populations which differed widely in their physical characteristics.

"Furthermore, all the facts indicate that this race is the product of elements borrowed from the three fundamental types, white, black and yellow, and this preliminary proposition, which all our later study will confirm, shows itself at once and clearly in a study of the traits which characterize the Polynesians."

"In a Tahitian head which belongs to the Museum, and which may be considered as an excellent type of the race, the skull, properly speaking, is high, moderately elongated from back to front; the curve which it describes from forehead to occiput is at first regular, but suddenly flattened at the back. The parietal prominences at the sides of the head are not very pronounced. The forehead is rather receding, although the frontal bone is well developed. The orbits are moderately far apart, the cheek bones slightly prominent, the bones of the nose raised and of medium development. The upper jaw is slightly protruding, in other words it is a little bit prognathous, and presents a somewhat massive appearance; the lower jaw is curved below and presents a prognathism that is little marked.

"The ensemble which I have just sketched indicates a fusion of the characters which one finds among the white, yellow and black races. They modify and efface each other reciprocally.

"On the other hand, we find in other skulls much more accentuated traits. In one, belonging to a native of the Marquesas islands, the general form of the skull approaches that of the Hindu; the forehead is raised, the nose more prominent, the upper jaw is hollowed, and the lower one does not protrude.

"Here the characters of the white race are incontestably most evident.

"In still other skulls, coming either from the same locality or elsewhere, the skull is lengthened and narrowed, the bony ridges become more pronounced; the forehead is decidedly receding, the superciliary ridges very prominent, the cheek bones thrust forward; the nasal bones, small and concave, are welded together like those of the Hottentots; the protruding jaws and teeth are as marked as among pure negroes.

"Here the predominance of the Melanesian type[2] becomes indisputable.

[1]A De Quatrefages, "Les Polynesiens et Leurs Migrations," pp. 6-9, Paris.

[2]The word Melanesians is commonly used to designate the negroes who populate a part of the South Sea Islands. The double maxillary prognathism, that is, the protrusion of both jaws, is one of the traits which distinguishes them from the negroes of Africa, among whom the upper jaw alone presents this appearance, as a general thing. On the other hand, the negroes of Guinea have a double dental prognathism, while the negro of Oceania often has the teeth of the lower maxillary almost vertical.—De Quatrefages.

"If one passes from osteological characters to those furnished by the living man, we find a complete concordance. Generally the dome of the head is high, a little short from back to front, and flattened at the back [from artificial causes]. The forehead is well-developed, but ordinarily a little low; it often becomes beautiful, and the facial angle equals that of a European. The nose, although a little too short, and flattened by manipulation during infancy[3], is often straight and prominent too; in some islands, it is almost always aquiline, a character which belongs essentially to the white race. The eyes, rather small, are almost always horizontal, rarely oblique; and black in color. The cheek bones are prominent, but usually protrude forward, as with certain white populations, rather than on the sides. The mouth is well formed and its expression agreeable, although the lips are slightly too thick, and usually present that peculiar clamminess which indicates negro blood; but sometimes they are as fine and thin as those of a European. The chin often projects forward to an exaggerated degree, and then becomes narrow and pointed. The color of the skin varies from a very pale bistre yellow, recalling that of certain Southern Europeans, to a dark brown, which sometimes passes into a copper color. Finally the black or light or dark chestnut hair usually has a tendency to roll into curls and is often enough wavy but never woolly. The characters of the hair alone attest that the yellow element forms an inconsiderable part in the composition of the Polynesian race, for hair invariably black, straight and impossible to curl is one of the most general traits of Mongolian populations, without a single exception, to my knowledge.

"To sum up, the Polynesian race offers characters belonging individually to the white, yellow and black; but the influence of these respective ethnological elements is quite different. The yellow element hardly shows itself except in the color; it seems to have little part in the formation of the facial appearance. The black element has more effect on the face, and often tends to darken the color of the skin. To it also must be attributed the waviness or disposition to curl which the hair often shows. But the element which is by far the dominant, at least in a part of the population, is the white. This assertion will probably surprise many readers; nevertheless, all that is necessary to recognize it for true is to read the narratives of travelers, in particular those which complete the voyages of Dumont-d'Urville and his companions."

[3]A flat nose is a great perfection and beauty for a woman.—Moerenhout.

Bismarck's Heredity

The heredity of Prince Otto von Bismarck, the "Iron Chancellor," is studied by the genealogist Dr. St. Kekule von Stradonitz in the Mitt. der Zentralstelle f. deutsche Personen-und Familien-geschichte (Heft 7, 1910). The results are briefly as follows: Bismarck's paternal ancestry shows two peculiarities: A rather badly obscured line of ancestry, and a derivation through the female line from the famous field marshal Derfflinger. The maternal line is unbroken in its exhibition of literary character (the Mencke family); the maternal great-grandmother of Bismarck, wife of the younger Gottfried Ludwig Mencke, professor at Helmstadt, belongs to one of the most noted families of the period. But uncertain links are also found in her ancestry. The great-grandmother referred to was the grand-daughter of Johann Witten, syndic of the Damenstift of Gandersheim, and son-in-law of the chairman of the syndics, Michael Büttner. He is the most noteworthy figure in Bismarck's maternal line; he died in 1677. The account of this man, given by Dr. von Stradonitz, shows, as he says, a remarkable correspondence to the character of Bismarck himself. And when one follows back Bismarck's ancestry until he has included 128 of his progenitors, he is inclined to admit the author's explanation, that Bismarck was "the atavistic product of a cross between the Derfflinger and Michael Büttner strains of germ-plasm."

PUEBLO INDIAN MAIZE BREEDING

Varieties Specially Adapted to Arid Regions Developed by Hopis and Navajos—Their Work Not Sufficiently Appreciated—Probably Much Yet to be Learned from Them.

G. N. Collins

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AMONG the many gifts that the white man received from the American Indian, maize is undoubtedly the most valuable. In the mythology of the Indian this cereal occupies a central position as the most important gift of the gods.

The power of minute observation commonly possessed by primitive people is highly developed in the agricultural Indian tribes of the Southwest. These Indians spend much of their time in their maize fields and it is only natural that the plant which supplies their principal food should come to be known in great detail. Every character of the plant, every operation in its cultivation and every stage in its growth are observed by the Indian with a minute attention in which he is seldom equalled by his white brother.

The ceremonies and care with which maize is cultivated by the Indians of the Southwest are well illustrated in a series of articles on "Zuni Breadstuff," by the late Frank Cushing, who showed that the importance of selection, care of seed, and cross-breeding, though not appreciated as such, are all given careful and conscious consideration by the Zunis.

According to Cushing, "In each corn-room or granary of Zuni, are preserved carefully, four objects; an ear of yellow corn full to the tip of perfect kernels, called a *yá-po-to;* an ear of white corn which has resulted from the inter-growth of two or more ears within a single husk-fold, called, from its disproportionate breadth and flatness, a *mi-k'iap-pan-ne;* a moderately large normal ear of corn which has been dipped by a Seed-Priest, in the waters of the great sacred Salt Lake far south of Zuni (*Las Salinas* of New Mexico), and a bunch of unbroken corn-soot. The latter two objects are laid side by side on the floor in the middle of the corn-room, and upon them also side by side, usually connected by a bandage of cotton filaments, the *yá-po-to* and the *mi-k'iap-pan-ne.*

"The significance of all this is both interesting and poetic. The corn-soot is held to symbolize the 'generation of life,' the salted and sanctified ear of corn, the material given by the gods and prepared by man, as the means whereby generated life is sustained, and finally, both these are regarded as the resting place or couch of the Father and Mother of corn-crops or seed; the *yá-po-to* being the male, the *mi-k'iap-pan-ne,* the female.

EARS SELECTED WHILE GROWING.

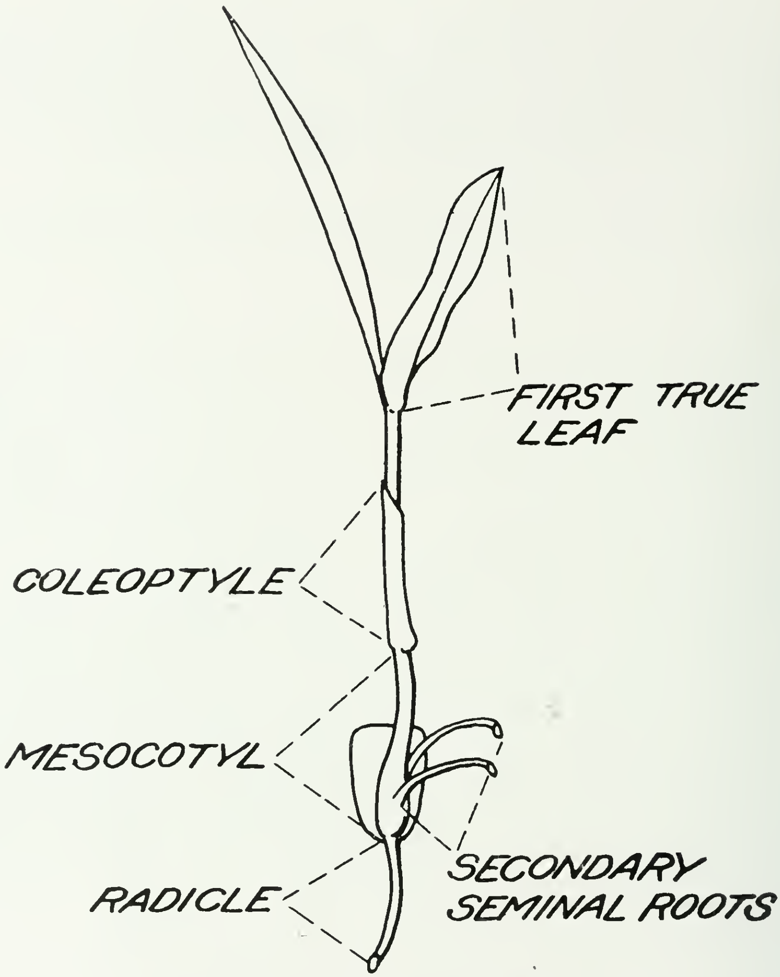
"In a field of growing maize the owner selects such hills as give promise of speediest maturity. These receive his special care. No sooner have a few ears ripened on them than he picks the most perfect, as well as a bunch of soot from some neighboring stalk, and tenderly carries them home in his arms. Arrived at the entrance-way of his house he calls to the women within:

"'We come!'

"'Ah! How come ye?' say they.

"'Together, happily,' he replies.

"'Then enter ye!' calls out the chorus of women's voices, whereupon the man goes slowly in. One of the women beckons his attention to the 'sitting place,' which, in this instance, is a decorated basket-tray in the center of the room. Thither he proceeds and



THE PARTS OF A SEEDLING MAIZE PLANT

This diagram will furnish the non-botanical reader with the names needed to understand the story of Pueblo Indian maize breeding. (Fig. 5.)

places, one by one, the ears of corn in the tray—using care that they shall all point eastward—and lays the bunch of soot over them. The women of the house flock to the mantel whereon stands the family bowl of prayer-meal, each taking a pinch of the sacred substance, while one of their number, the 'corn-matron,' hastens away to the granary, and carefully lifting the *ya'-po-to* and *mi-k'iap-pan-ne*, brings them forth. As she nears the tray, she says, across the objects in her hands (addressing the new corn), 'My children, how be ye these many days?' Then the new corn is supposed to reply through the voices of the other women, now gathered near, 'Happily, our old ones, happily!' With this the corn matron deposits her burden on the new bunch of soot, and all present say little prayers significant of the occasion and setting forth their wishes for 'age of life, happy fortune and the health of strength born of the food of maize.' This ceremonial is called the 'Meeting of the Children,' and is performed in commemoration of the return of the lost corn maidens under the guidance of *Pai-a-tu-ma*, and their welcome by the Seed-Priests of ancient Zuni.

"With the closing of the prayers, the right hand of each worshipper is passed gently over the tray—while scattering prayer-meal—and breathed from. The corn-matron then returns to the granary, bearing both the old corn and the new. She replaces the old bunch of soot with the new, laying the former away with the fresh ears of corn, and returning the *ya'-po-to* and *mi-k'iap-pan-ne* to their resting place.

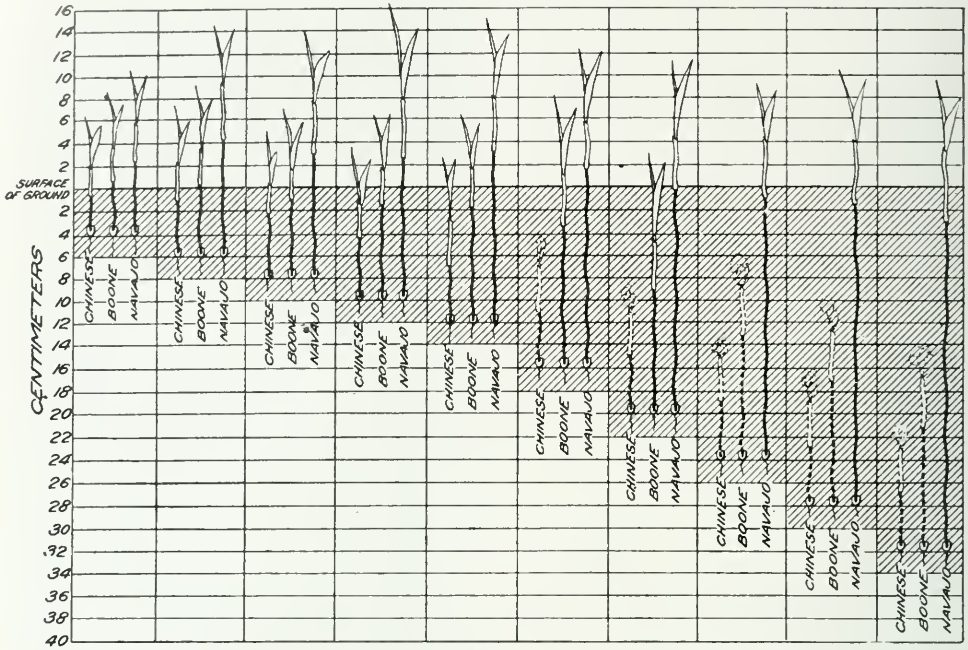
EARS CAREFULLY SORTED.

"When all the harvest has been gathered, dried, sorted and corded up, around and over the 'Father and Mother' in the corn-room, the ceremonial interrupted at the beginning is resumed. While the corn is being classified as to color and grade, the finest ears of each kind are selected and laid aside. These, and the ears of 'new corn' are together laid along the outer edge of the corn-pile. Next morning the corn-matron takes a basket tray—perhaps the same one used before, or at least one like it—and goes to the door of the corn-room. Here she slips off her left moccasin, then enters. As she passes the threshold she looks around as though she were about to address a group of waiting friends and exclaims:

"'My mothers and children, how be ye, and how have you come unto the morning?' and after a moment herself replies: 'Happily!'

"Reverently, for she is in the presence of the conscious and the benign—so it seems to her—she approaches the cord of corn and with her left hand takes of the selected ears along the top, an ear for each finger (that is, four), then with the right hand an equal number, placing them in the tray. She brings these forth and assisted by the male head of the household, shells them with such care that not a kernel is lost. Dust from the old bunch of soot is scattered over the shelled corn, and a curious sacred pigment is prepared, in an earthen ladle, of yellow paint and a kernel of salt, from the mountain near the lake of the dead, and the salt lake in the South. To these ingredients are added two or three kinds of little yellow flowers, the principal variety being precious in the eyes of the Zuni, as that

Seedling of Hopi maize planted eight inches underground. The first permanent roots can be seen sticking out seven and one-half inches above the seed. (Fig. 6.)



SUPERIORITY OF NAVAJO MAIZE FOR DEEP PLANTING

Test plantings of the Navajo dry-land maize, and Chinese and Boone County White, were made in a box at the depths shown in the diagram. The Navajo surpassed its competitors in growth at all depths; but from the lower levels it was the only one to emerge, due to its extraordinary adaptation for such growth, through the elongation of its mesocotyl. The diagram shows that at intermediate depths the Chinese and Boone varieties could not force their coleoptyles to the surface, and were obliged to make the last few centimeters of the distance by the aid of the true leaves, which in general are ill-adapted to pushing through solid earth. (Fig. 7.)

which was left over of the seed stores of the gods. All this is mixed with pollen and water, and the whole tray of kernels is thoroughly sprinkled and anointed by stirring. The corn grains thus treated are bright-yellow in color and pleasantly odoriferous. All this is done that the 'seed' may have the power of reproduction, rapid growth and strength, and that it may bear fruit possessed of the properties of food, which fruit shall mature with the season when thrive most and bloom the little yellow flowers,—early autumn.

SUCCESSFUL SEED SELECTION.

"We are at first surprised when we learn that to a remarkable degree the corn thus treated has vigor and the quality of ripening early; but our wonder may be lessened when we reflect that these seeds are the most perfect of the whole harvest, selected mostly from among those ears which soonest reach maturity. Still, with the Zuni all these things are living testaments of faith, proving the infallibility of his theory of Medicine or Fetichism and of his practice of religion."[1]

Mr. Cushing lived with the Zunis for a number of years and became a member of the tribe. He succeeded to a remarkable degree in attaining the Indian point of view, but appreciation of the Indians did not lessen his zeal for accuracy. This series of articles written in a charming literary style tells not only what the Zunis eat and how they secure their food, but gives a tantalizing glimpse of the character and personality of the Zuni.

In other articles of the same series the cultural methods of the Zunis are described. Though mixed with super-

[1] "Zuni Breadstuff," V, Frank H. Cushing, The Millstone, Vol. IX, Nov. 5, 1884.

stition, the methods employed are seen to be admirably adapted to supply fertility to the soil and to conserve moisture, enabling these Indians to produce maize under conditions that prohibit the growing of this crop by the methods ordinarily employed by whites.

The many incidental references to peculiar agricultural practices in Mr. Cushing's articles suggest that careful study of the agricultural practices of the different Indian tribes might disclose many facts of economic importance to agriculture. The results described in the present paper show one such fact: that we must thank the Indian for calling our attention to deep planting as a factor in drought resistance and for having developed a type of maize with peculiar characteristics that permit the utilization of this factor to an extraordinary extent.[2]

VALUABLE LORE NEGLECTED.

The development of maize as a cultivated plant must have involved a long series of unconscious experiments which resulted in important agricultural discoveries. That the results of these experiments are clothed in the language of myths and legends should not obscure the fact that in many instances they reveal sound agricultural principles. The study of this primitive agricultural lore has too long been left to the ethnologist. We have accepted the Indian's gift of maize but have hastened away without stopping to learn its full value or how best to utilize it.

Had we taken the trouble to learn and appreciate the Indian's discrimination in the choice of varieties, the differences in flavor and adaptability to different methods of cooking, we would not have assumed this valuable human food to be useful chiefly for the nourishment of our domestic animals.

Indians of the Southwest have preserved from pre-Columbian times a type of maize able to produce fair crops in regions where the better-known varieties of the East fail for lack of sufficient water. An important factor in the drought resistance of this type of corn is its ability to force the growing shoot of the seedling to the surface of the soil when planted at a depth of a foot or more. At such depths less specialized varieties die before reaching the surface.

The literature of corn contains reports of many experiments conducted to determine the proper depth of planting, but the results are confusing and contradictory. It has generally been realized that the optimum depth is influenced by differences in soil and climate, but that the proper depth might vary with different varieties seems not to have been appreciated. The varying behavior of types when planted at different depths is additional proof that it is unsafe and unscientific to generalize with respect to cultural factors without taking type, varietal and even individual differences into account.

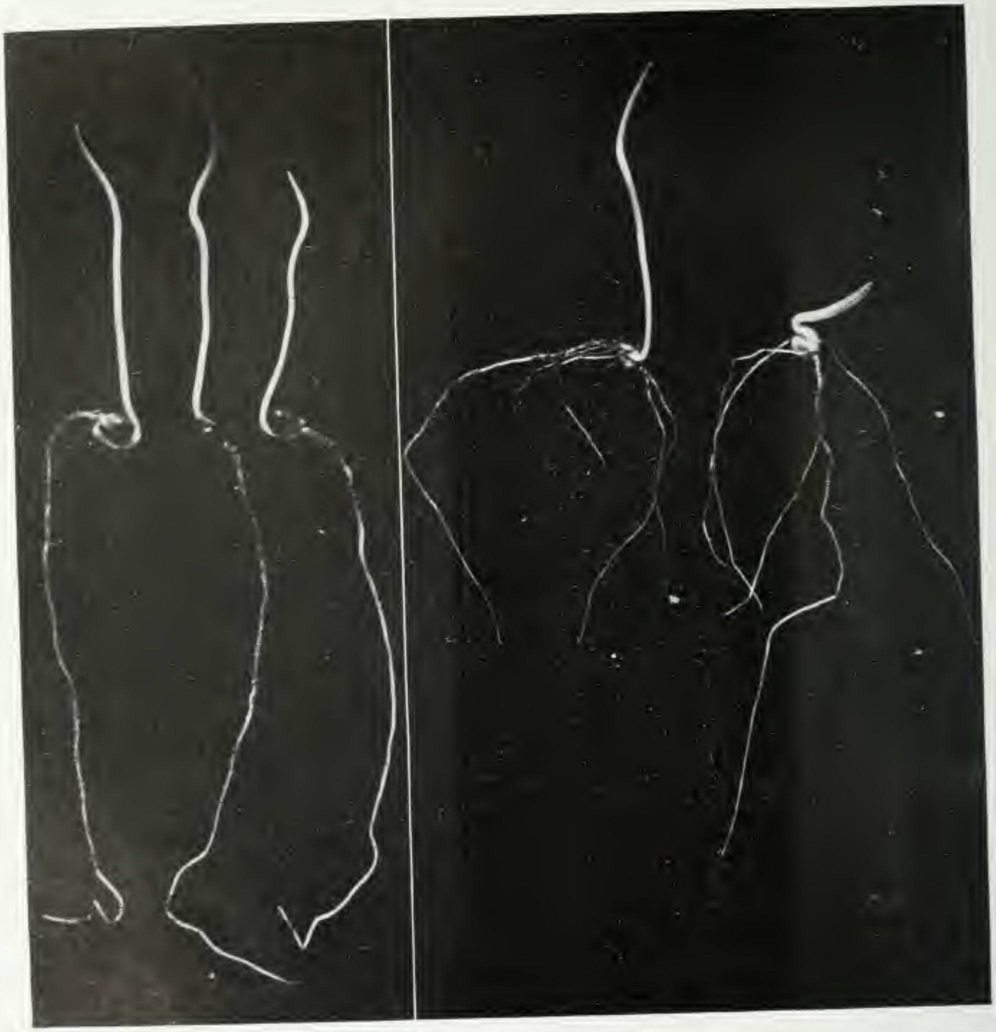
The primary root or radicle which is the first organ to emerge from the germinating seed is soon followed by the shoot or plumule. Enclosing the shoot is the cotyledonary sheath or coleoptyle, a tubular organ which is closed and pointed at the upper end. Between the base of the coleoptyle and the seed, the axis is somewhat elongated (see Fig. 5). With seeds germinated in the laboratory this elongation is so slight that it might easily be overlooked. Nevertheless, this small organ has not escaped the notice of morphologists and its nature has been the subject of much discussion. It has been called variously hypocotyl, mesocotyl and epicotyl. By some it is held to be an internode, by others merely an elongated node.

HOW THE SHOOT REACHES DAYLIGHT.

When a grain of corn germinates in the ground this usually insignificant organ is of vital importance to the life of the plant, for it is through the elongation of this mesocotyl that the shoot is enabled to reach the surface.

So long as a maize seedling remains below ground away from light, the mesocotyl will continue to elongate, until it reaches a maximum length that

[2]The description of the drought resisting adaptations of this type of maize has been published in The Journal of Agricultural Research, Vol. 1, No. 4, Dept. of Agriculture, Washington, D. C., January 10, 1914, where the subject is treated in a somewhat more botanical way.



SPECIALIZATION IN HOPI SEEDLINGS

The varieties bred by the Indians of the southwest have but one seminal root, as shown in the three seedlings at the left (fig. 8); and they are able to throw their entire energy into the prolongation of this single radicle, so that they can force it down into moister ground, as the moisture recedes during periods of drought. Ordinary varieties like the Chinese, two seedlings of which are shown at the right (fig. 9), throw out several seminal roots and are obliged to divide their energy; thus they can not reach to the depths which the single radicle of the Hopi variety attains. In the struggle for existence during drought, the Hopi variety thus possesses a decided advantage.

varies in different varieties of maize. As the mesocotyl elongates, the coleoptyle with its firm, sharp point is pushed upward through the soil. As soon as the coleoptyle emerges from the soil the elongation of the mesocotyl ceases and elongation of the internode bearing the first true leaf begins, forcing open the coleoptyle.

If the seed is planted so deep that the maximum elongation of the mesocotyl fails to bring the coleoptyle to the surface the task of penetrating the soil and reaching light devolves upon the first true leaves. In comparison with the sharp coleoptyle, these leaves are but poorly adapted for forcing their way through the soil, and if the tip of the coleoptyle stops more than a few centimeters below the surface these leaves usually crumple and never reach the light.

In the varieties of maize commonly grown the mesocotyl can seldom be forced to a length greater than four inches, while in the Hopi and Navajo varieties this usually minute organ may reach the relatively enormous length of 10 or even 12 inches, thus making it possible for these Indians to plant their maize deep in the ground where the soil is moist and germination is assured.

The mesocotyl is a beautiful contrivance for removing the young seedling from the seed and planting it at the proper depth from the surface. The true base of the plant is the base of the coleoptyle, the point from which the permanent roots arise. Since elongation of the mesocotyl ceases when the tip of the coleoptyle reaches the light, the length of the coleoptyle determines the depth at which the first permanent roots develop.

Figure 6 shows a seedling of Hopi maize as it developed when planted eight inches below the surface of the ground. The first permanent roots can be seen developing at the base of the coleoptyle 7½ inches above the seed.

GERMINATION OF NAVAJO MAIZE.

In the fall of 1912, W. T. Swingle and K. F. Kellerman of the Bureau of Plant Industry visited the region about Shiprock, N. M., in the Navajo reservation, and secured specimen ears of the maize grown by the Navajos. This collection was kindly placed at the disposal of the writer. Additional seed was later secured through the courtesy of Wm. T. Shelton, agent at Shiprock.

It has been frequently stated that the Navajos, like their neighbors the Hopi and Zunis, plant maize at unusual depths, 6, 12 and even 18 inches having been reported. Since planting at such depths was known to be impracticable with other varieties, an experiment was planned to test the ability of the Navajo maize in piercing the soil. A box, 70 cm. by 33 cm. and 34 cm. deep was sunk in the ground. A quantity of sandy loam soil sufficient to fill the box was slightly moistened and carefully sifted. At one end the box was filled to within one cm. of the top, the soil sloping in a straight line to within one cm. of the bottom at the other end.

Five seeds each of Navajo, Boone County White, and Chinese maize were placed in a row transverse to the inclined surface of the soil, two cm. from the top of the box.

A similar row was planted at four cm. from the top, and so on at the following depths: 6, 8, 10, 12, 16, 20, 24, 28 and 32 cm. The box was then filled with the soil and struck off level with the top. The seeds germinated promptly, and when the most advanced seedling had reached a total height of about 60 cm. the plants which appeared above the surface were dug up and the mesocotyl and coleoptyle were measured (see Fig. 7).

Twelve cm. was the greatest depth from which Chinese seedlings appeared at the surface. Boone seedlings appeared from all depths up to 20 cm. while Navajo plants appeared from all plantings to the very deepest, 32 cm.

There were numerous instances where the combined length of the mesocotyl and coleoptyle was less than the depth at which the seed was planted. This, of course, means that the upper layers of the soil were penetrated by the true leaves. The maximum depth of soil thus penetrated by the true leaves of the plants of the Chinese variety was five cm. One Boone plant forced its leaves

ZUNI PLANTATION OF MAIZE IN ARIZONA

The soil is sandy and, except during rains, is quite dry on the surface. The seeds are planted at five to seven inches below ground, where there is sufficient moisture to germinate them; and as the ground dries out to lower levels, they thrust their single seminal roots farther down, so that they remain green and vigorous while plantings of ordinary varieties of maize under similar conditions dry up and perish. This photograph was made near Black Rock, Arizona. (Fig. 10.)

through eight cm. of soil. In all of the Navajo plants the coleoptyle reached the surface.

The extent to which the Chinese and Boone seedlings were able to penetrate the soil by means of the true leaves was doubtless much greater in the carefully prepared soil of the experiment than would be the case under field conditions where any slightly compacted lump of soil would deflect the tender leaves and cause them to crumple. On the other hand, many seedlings failed to come up where there was less than two cm. between the top of the coleoptyle and the surface of the ground. The results clearly show that the coleoptyle is the proper organ for penetrating the soil and where this office devolves upon the leaves, germination is uncertain.

It has been observed in many field plantings that the spatulate first leaf, formerly called the cotyledon, is the first evidence of the germinating plant. When this occurs in any considerable proportion of the plants, it is safe to assume that the seed has been planted too deep for the best results.

In examining these experimental plants it was observed that the root system of the Navajo variety differed from that of the other varieties. The roots of the Navajo seedlings extended to a greater depth, but there was only a single root arising from each seed, while in the Chinese and Boone seedlings the roots were shorter and more numerous. Further experiments with Hopi and Zuni varieties showed them to be like the Navajo variety in producing but a single root from the seed.

The roots of maize are of two kinds, those that rise from the embryo or seed, called seminal roots, and those produced from the nodes of the plant. Of the latter class, those that arise from the nodes above the ground are often called brace roots or aerial roots. In the varieties commonly grown in the United States there are, in addition to the primary root or radicle, from two to six additional roots that arise from the base of the cotyledon. These secondary seminal roots, though appearing somewhat later, usually equal or exceed the radicle in size. In the Pueblo varieties of maize these secondary seminal roots have been absent in all seedlings thus far examined, the radicle being the only root arising from the seed (see Figures 8 and 9).

FIELD STUDIES OF PUEBLO MAIZE.

In September, 1913, opportunity was afforded for a short visit to the Zuni, Navajo and Hopi Indian reservations of Arizona and New Mexico. It was thus possible to form some idea of the agricultural significance of the peculiarities and habits of germination of this type of maize.

The value of deep planting made possible by the greatly elongated mesocotyl was obvious. In the localities selected by the Indians for planting maize the soil is sandy and in the absence of spring rains the surface layers are, of course, very dry. The seed, to germinate at all, must be planted deep enough to be in contact with the moist soil. In Navajo fields near Tohachi, N. M., plants were dug up and the remains of seeds were found at depths ranging from five to seven inches below the surface. Similar depths were found in a Zuni field near Black Rock, Arizona (see Figure 10.) In a Hopi field at Polacca, Arizona, near the first mesa, where the conditions are extreme, the seed had been planted at 10 inches from the surface. It thus appears that there is no fixed depth for planting, the custom being to plant deep enough to place the seed in moist soil. If the seed were planted at ordinary depths, germination might be delayed until the latter part of June or the first of July, at which time the rains usually occur, or if the seeds germinated as a result of one of the occasional showers occurring in May, the plants would die from subsequent dessication.

Like the long mesocotyl, the simple radicle of the Pueblo maize may be looked upon as an adaptation to the extreme conditions that exist where this type is grown. For six or eight weeks after planting no rain can reasonably be expected and during this time the moisture is constantly receding from the surface. By concentrating the energy of the seedling into a single root the latter is forced to greater depths and consequently kept in soil that is more

HOW THE HOPI INDIANS GROW MAIZE

Field at the base of the first Hopi mesa, near Polacca, Arizona. The hills are planted about 20 feet apart with 10 to 20 plants in a hill. The soil was apparently pure sand washed down from the mesa by winter rains, and was so dry that not a weed was to be found. In such unfavorable conditions the maize seeds planted at a depth of about 10 inches (25 cm.) had sent down their single, vigorous radicles or seminal roots to a depth of 14 or 15 inches more, so they were drawing moisture from a depth of at least two feet below the surface. No variety of corn cultivated in the eastern United States could possibly survive under such extreme conditions. (Fig. 11.)

MAIZE GROWING UNDER DIFFICULTIES

With most of the improved varieties of maize, the plant's chief concern seems to be to produce leaves and stalk. The ear is the last thing to receive its attention; in consequence, the ear is the first part of the plant to suffer under extreme drought or other unfavorable conditions. The habit of the Pueblo varieties is just the reverse; they seem determined to produce seed, even if they accomplish little else in life. A plant of this kind is shown here, where the single ear is more than one-half the height of the entire plant. (Fig. 12.)

moist than would be the case where a number of seminal roots developed.

Thus under ordinary conditions where moisture is distributed through the entire seed bed the seminal roots become of little importance as soon as the seedling is established and nodal roots have developed. If a half grown or nearly mature corn plant is carefully dug up, the seminal roots and traces of the seed can still be found but they are usually dry and shrunken and are obviously of little use to the plant. This was also the condition found in Navajo and Zuni maize fields, though the seminal roots were more strongly developed than in the eastern varieties. But, in the more extreme conditions existing in the fields near the Hopi villages, where, as stated, the seeds were planted deeper, it was found that the seminal roots were relatively much larger and were still alive and fresh, making it apparent that they retain their function of supplying moisture, and are able to play an important part during the entire life of the plant.

HOW THE MAIZE IS GROWN.

In one field at the base of the first Hopi Mesa the hills of maize were planted about 20 feet apart with from 10 to 20 plants in a hill (see Figure 11). The soil was apparently pure sand washed down by the winter rains and entirely destitute of vegetation other than the planted maize. An average hill dug up in the field was found to contain 15 plants ranging from 60 to 90 cm. in height. The remains of the seeds were found at 25 cm. from the surface and from each seed there descended a single large seminal root. These seminal roots were traced to a depth of 35 cm. and extended even farther down. They were still fresh and densely covered with fine branches. This mass of 15 seminal roots, while less in volume than the nodal roots arising near the surface, was apparently playing an important part in the support of the plants. The mesocotyls connecting the seminal roots with the plants above, while dry on the outside, were filled with live tissue quite unlike the dry and shrunken mesocotyls found in plants of similar age grown under more favorable conditions.

When planted by the Indian methods, the Hopi and Navajo varieties of maize have been found superior to the more improved eastern varieties for these very dry regions. At the time of our visit there was a small field near Keams Canyon that had been planted by eastern methods. The plants were in rows and thinned to one stalk to the hill. There had evidently been a fair germination but the plants had died without reaching maturity and had produced no seed. At the same time in the nearest Indian fields at Polacca the plants were dark green and maturing a fair crop, though the season was said to have been unusually dry.

Under extreme drought or other unfavorable conditions the persistent tendency of this type of maize to produce seed is very striking. Where any growth is possible it seems to be expended in the production of seed. Many plants were seen where the length of the ear was equal to one-half the height of the entire plant. A plant of this kind is shown in Figure 12. With most of the improved varieties of maize the ear is the first instead of the last part of the plant to suffer when unfavorable conditions are encountered.

Even under irrigation the somewhat larger strains grown by the Navajos have been found to compare very favorably with eastern types. Several acres of Navajo maize were seen at Shiprock, N. M., under irrigation. The fields were very uneven, apparently the result of alkali, but in the better portions the yield was good. The plants were standing about two feet apart in the row, the rows four feet apart, and nearly every plant was bearing from two to four fair sized ears (see Figure 13). The ears from 36 plants representing a number of distinct types were collected. The 36 plants bore in all 94 ears weighing 37.6 lbs., an average of 15.2 oz. per plant. The plants producing these ears averaged only a little over five feet in length.

CONCLUSIONS.

American agriculture is under obligation to the American Indian for having developed the maize plant to a high state of efficiency and for having adapted it to a wide range of environment.

NAVAJO MAIZE GROWN UNDER IRRIGATION

A single plant photographed, with the leaves and husks removed, at Shiprock, New Mexico. Although these Indian types of maize are particularly adapted to dry-farming, their yield under irrigation compares favorably with that of the ordinary commercial varieties. (Fig. 13.)

The importance of the unconscious pioneer agricultural work of the Indian has not been adequately appreciated. Many of the agricultural requirements of maize laboriously ascertained by experiment might have been learned from a study of the agricultural practices of the Indian.

The agricultural Indians of the Southwest have continued, from prehistoric times, to grow maize successfully in regions where drought, and especially the absence of spring rains, make the growing of the common varieties impossible. A study of the varieties grown by the Hopi and other agricultural Indians shows that these varieties possess two special adaptations: (1) A greatly elongated mesocotyl that permits deep planting and (2) the development of a single large radicle that rapidly descends to the moist subsoil and supplies water during the critical seedling stage.

This indigenous type of maize seems to have attracted little attention, perhaps because it has been included in the popular mind with a series of inferior varieties commonly known as "squaw corn." But the Pueblo Indians of Arizona and New Mexico have strains sufficiently productive to compare favorably with improved varieties even when grown under irrigation. The peculiar adaptations of this type definitely indicate its value for the semi-arid regions, and warrant experiments to determine the possibility of its utilization.

It is believed that a canvass of the varieties of maize grown by the Indians and a careful study of the agricultural practices of the different tribes will disclose much of interest and value to American agriculture.

The First and Last Child

With a view to throwing light on the question whether the first-born children, or the last-born children in large families, are inferior in vitality to the rest of their fraternity, Dr. Alfred Ploetz of Munich, Germany, compiled the returns from a large number of families of the nobility, and published them in the Archiv für Rassen und Gesellschafts-Biologie (VIII, 761). He does not interpret his figures, but they seem to show very little difference in the viability of children in a family, with regard to their order of birth.

He grouped all the first-born children together, all the second-born children together, and so on, and then found how many of them had died before the fifth year of life. The results, so grouped, are as follows:

Order of Birth	Number of Children Included	Per Cent. That Died
First-born children	614	26.4
Second-born children	539	24.9
Third-born children	455	26.4
Fourth-born children	386	25.6
Fifth-born children	311	26.0
Sixth-born children	249	26.1
Seventh- to ninth-born children	463	26.3
Tenth- to nineteenth-born children	302	34.4
Totals	3319	26.7

A RADISH-CABBAGE HYBRID

Cross Between Two Genera Shows Extraordinary Vigor but Absolute Sterility—Pollen Irregular Both in Size and in Shape—Two Extra Stamens Present in Some of the Flowers.[1]

FLIPPO GRAVATT, *Blacksburg, Va.*

IT IS a general rule with organic forms that whenever their systematic differences are very great, they will not hybridize with each other. A large number of species will hybridize with other species of the same genera, though the product obtained is usually sterile. The great majority of species will not hybridize with other species of the same genus. In regard to crosses between different genera a good many have been reported. Each of these successful crosses represents hundreds of unreported failures, owing to the great difficulty in effecting such a cross. These generic crosses have been effected in various different families, both in the Dicotyledons and in the Monocotyledons.

In the Cruciferae, mention was found of one .generic cross, that between the garden radish, *Raphanus sativus*, and the garden cabbage, *Brassica oleracea*. This cross was made by Segeret, a German, many years ago, although there seems to be doubt about it in the mind of Fockle, who reports Segeret's work.

The chief distinction between the genera Raphanus and Brassica are that the pod of the former is one celled or with spongy transverse partitions, while that of Brassica is longitudinally two celled and dehiscent. Between the two species there are a number of differences, but these will be noted later. The radish and the cabbage have both been developed in cultivation for hundreds of years.

In the greenhouse during 1910 a large number of flowers of three different varieties of radish were emasculated and bagged. Two days later, when most of the stigmas were in receptive condition, they were pollinated with pollen from a cabbage plant which was a first generation hybrid between the varieties "Volga Russian" and "Curled Savoy." Perhaps the fact that the cabbage plant was a hybrid had something to do with the success of this generic cross. The bags were left over the pollinated flowers for two weeks. At the end of that time all had dropped off except two small pods of the variety "Long Scarlet Short Top." A large number of cabbage flowers were emasculated and pollinated with different varieties of radish, but no fruit set.

In September, 1910, the contents of these two pods, consisting of several small, shriveled seeds, were planted. Only one came up and from the first it could be seen that it was a cross. It was very vigorous and grew rapidly, finally being transplanted from a 20 inch pot to a central bed.

CHARACTER OF THE HYBRID.

The hybrid produced a great abundance of large leaves. In size and shape they are nearer to the cabbage, but are much larger than those of either parent. The largest leaf of the cross was five feet nine inches from tip to point of attachment, and one foot seven inches broad. The leaf was measured at the time the plant started blooming.

In color the hybrid leaf is a mean between the light green of the radish and the dark or blue green of the cabbage. In taste it is more like the cabbage, but one can still detect some of the radish pungency. The radish leaf is pubescent with stiff hairs, while the cabbage leaf is glabrous. Leaves of the cross are nearly glabrous. The

[1]This work was carried on during post-graduate studies at Virginia Polytechnic Institute under Prof. H. L. Price and Prof. E. A. Smyth.

RADISH-CABBAGE HYBRID WHILE YOUNG

The growth habit of both parents is similar to that here shown, when they are young. Later the cabbage "heads up" and the radish does not; the hybrid followed the radish in this respect, but did not develop any tuberous root such as the radish produces. (Fig. 14.)

cabbage leaf is much thicker than that of the radish: leaves of the cross are intermediate between the two.

It would seem likely that the hybrid would inherit some tendency towards tuberous root formation from its radish parent, but such did not seem to be the case. The hybrid does not even show a well developed main tap root, but divides into numerous branches at a short distance below the surface.

The stem of this hybrid is several times larger than the combined stems of the two parents. When the hybrid reached the size shown in figure 15, the circumference of the stem was 13½ inches, measured at a distance of one foot from the ground. The stem holds its size for some distance from the root. The lower part or about the first two feet of the stem is very thickly beset with leaves, thus resembling the cabbage in habit. These leaves drop off on account of shade from above, leaving large and prominent scars. Starting from the surface of the ground, the major portion of the stem is a purplish red color just the same as that of the radish, but this purplish red color covers the stem of the hybrid much more thoroughly and extends further up than it does on the radish parent.

GROWTH HABIT.

When still young the general growth habit of the radish and of the cabbage is quite similar. It is a spreading, diffuse growth. It is not long, however, before the cabbage begins to head up and packs most of its leaves into a solid, bud-like formation. Some time after this head reaches maturity, the bud begins growing in the center, by its development breaks the head open, and then grows upward rapidly, being nourished on the food stored in the thick leaves.

AN EXAMPLE OF HYBRID VIGOR

Hybrid forms usually excel either of their parents in vigor, and agriculturists have long taken advantage of this fact, in the production of both plants and animals. It is seldom, however, that so much extra energy is shown as by this cross between radish and cabbage, neither of which ordinarily reaches great size. The cross continued growing for five months after the above photograph was taken, and at the time it was killed by bacterial rot, it had gone through the ventilator of the greenhouse and was traveling down the roof on both sides. (Fig. 15.)

The radish differs from the cabbage in that it retains its open diffuse habit of growth. Instead of forming a solid head of leaves, it develops a tuberous root and in this stores its surplus food. Then when the radish reaches maturity, a bloom stalk is sent up, being nourished chiefly on stored food from the root.

The hybrid has an open, diffuse growth habit. During the stage in which the radish develops its root and the cabbage its head, the hybrid continues to develop numerous large leaves. These leaves are so thick that a large number of the lower ones die and drop off, due to lack of light.

At first there is a single elongated shoot, but sometime before blooming, numerous side branches start out. In figure 14, the side branches are just starting. The main shoot develops into a bloom stalk just as in the case of the

parents. This one is shortly followed by others from the side shoots. These bloom shoots attain a much greater length than those of either of the parents. The side shoots make a growth of several feet before any buds are developed. Figure 15 shows the enormous growth of this hybrid. It continued to grow for nearly five months after this photograph was taken, finally being killed by a bacterial rot of the root and stem. At the time of its death the hybrid had grown out through the ventilator and for a short way down the roof of the greenhouse on both sides.

FLOWERS.

The pediceled flowers of this hybrid are borne on a greatly elongated rachis, which in some cases attains the length of three feet. The flowers of the parents are borne in the same way, though the flowering axis or rachis does not grow to such a length as with the cross. Perhaps the greater length of the rachis was due to the fact that no pods set and therefore all the food went to the development of the flowers.

The buds of the radish are obovate in shape, while those of the cabbage are oblong-elliptical and much larger and longer. The buds of the cross are a mean between those of the two parents in shape and size. Near the top of the bud of the radish, there are several prominent hairs growing out from the sepals. The cabbage and the radish-cabbage cross do not have these hairs.

The cross has four petals, intermediate in size between the two parents. The radish parent was dominant in regard to color of the petals, the background color being white with a purplish tinge and veins. There was no sign of the rich yellow color of the petals of the cabbage parent.

The radish and cabbage flowers each have six stamens. Most of the flowers of the cross had six stamens but a good many had two extra well developed stamens, making eight. There were about 15% of the flowers which showed this variation. These two extra stamens bring up some interesting questions which will be discussed in another article.

It was noticed that the pollen from this cross was not powdery and light as that of the radish and cabbage, but stuck together and had a tendency to ball up. There was often difficulty in spreading the pollen out on the stigma. On examination it was found that the pollen from the radish and that from the cabbage were very regular in size and shape, while that of the hybrid was very irregular in both respects. Attempts to germinate the pollen from the hybrid in various solutions all failed.

Most of the ovaries of the hybrid appear to be two-celled like those of the cabbage parent. One slide of a hybrid pistil showed sections of an ovary with three cells.

STERILITY OF THE HYBRID.

About crosses between species De Vries says: "Whenever their systematic differences are too great, the crosses will be infertile, even with the pollen of their parents. Repeated crosses are impossible and no practical results can be obtained." Generic crosses are nearly always sterile. Most of them do not even produce flowers and if they do, the flowers are usually aborted in some way.

In March, 1911, this hybrid started blooming in great profusion. Nearly every day during March, April and May, pollen from different varieties of radish and cabbage, including the parents, and from cauliflower, collards, Brussels sprouts and their crosses, was tried on the flowers of the radish-cabbage hybrid, but nothing resulted. The hybrid was also sterile to its own pollen. Flowers of the radish, cabbage and various Brassica crosses were emasculated, bagged and pollinated with the hybrid pollen, without results. The same process of pollination was gone through in the winter of 1912 with a root cutting of the hybrid and again resulted in failure.

ORIGIN OF THE BANANA

One of Earliest Crops Cultivated by Man—Perhaps Valued at First Only for its Roots—Doubt as to Time of its Introduction to America—Prehistoric and Allied Forms—Irregularities of its Behavior in Cultivation.

THE EDITOR.

THERE seems little reason to doubt that the banana was one of the first foods of man, and that it was one of the first plants cultivated.

"Wild bananas and their botanical relatives," says O. F. Cook,[1] "are natives of the rocky slopes of mountainous regions of the moist tropics, where shrubs and trees prevent the growth of ordinary herbaceous vegetation." It is probably in a similar region that the first appearance of Man is to be looked for. "Everything leads one to believe," as Beccari[2] says, "that the principal cultivated fruits originated in the region where man first acquired a high grade of civilization." Primordial man of the tropics was undoubtedly an agriculturist rather than a live-stock breeder. He lived on the resources most readily furnished him by nature, and among these, few would be more readily available than the banana. It is permissible, then, to suppose that the banana was one of the first fruits which attracted his attention; that he soon brought it under cultivation, and that he at once began to submit it to that long process of improvement which has continued for some hundreds of thousands, perhaps, of years, and is more active today than ever before.

If Man appeared in the Indo-Malayan region, as is widely believed at present, it seems natural to seek for the origin of the banana in the same region; and, such a location for it is accepted by most botanists. This primitive banana probably did not differ widely from the wild bananas found today in many parts of the tropics, although none of the latter can be confidently pointed out as representing the ancestral type. Beccari, indeed, considers that all the wild forms known today are merely cultivated forms which have escaped from cultivation at some time in the past. He found in Borneo four new species which grew only in regions deforested by man Whence were they brought? he asked himself, and was obliged to conclude, after a survey of the whole problem, that probably each region develops its own well characterized species of Musa —a conclusion which finds support in the fact that no species yet known has a very wide geographical distribution. At present the genus seems to be dependent on man for its possibilities of development: it can not make its way in the primitive forest, he concludes. It is one of the many crops which have been so changed by man to meet his own needs that they are no longer able to hold their own in the free competition of nature.

ROOTS AND HEART EATEN.

The original form of banana must have been of little value as a fruit. Cook has therefore concluded that it was first a root crop, the roots even yet being used by the natives of some regions, while the tender heart was doubtless also an article of food, as it is today in Abyssinia. Cultivated for its roots, the banana began to produce better fruits, by chance, or as a result of asexual propagation, and at a very early day must have become more prized for the latter than for the former.

"The wild varieties are almost wholly seeds," Beccari observes, "but what pulp exists is sweet and agreeable. It therefore only requires some agent to

[1]Annual Report Smithsonian Inst., p. 481, Washington, D. C., 1903.
[2]Beccari, Odoardo, Nelle Foreste di Borneo, p. 611. Firenze, 1902.

inhibit the growth of seeds and promote that of pulp to produce good bananas. Effective causes are sterility produced by hybridization, and improvement by asexual reproduction." Both of these means may have been used by the prehistoric plant-breeders of the tropics. Cross-pollination between different species would easily take place, and would result in at least partial sterility of the product. These hybrids, asexually propagated either by man or by nature, would retain their sterility, and a "horticultural variety" would be established. Beccari's own idea is that all the bananas of today are, in fact, the results of hybridization of various original wild forms which have now disappeared. This in itself would be sufficient to explain the seedless condition of the fruit of commerce; while the numerous seed-bearing species found wild at present are accounted for by Beccari's hypothesis that they represent the product of one of the normally sterile forms pollinated from some species sufficiently distinct to cause the production of normal seed.

VAGARIES OF POLLINATION.

This hypothesis, although somewhat unusual, is given color by recent work in Jamaica, described by Fawcett.[3] Experiments in pollenizing the ordinary, sterile varieties, at the Hope Gardens, were unsuccessful until pollen from the distinct but equally sterile red banana (var. rubra) was used; the normally seedless commercial bananas then set a full complement of seed. He quotes a similar observation from A. d'Angremond[4]: "Most of the pollen of the Jamaican and Apple bananas is sterile, and only a few of the ovules in those plants have an embryo sac. However, dusting the ovaries of these cultivated fruit plants with pollen of *Musa basjoo* and *M. ornata* [two wild species] was sufficient to produce seeds."[5]

Seeds may be produced in an ordinarily sterile variety as a result of environmental conditions, if there is any basis of fact in the story given to O. W. Barrett[6] by a Porto Rican native, who advised: "Get a stool of bananas growing rapidly in shallow soil by the addition of artificial fertilizers; let one bunch of fruits set; but before that ripens, cut down all but one of the stems in the clump. The remaining shoot, 'thinking it has but one more chance to perpetuate its kind before being killed,' on account of the tremendous shock to the more or less connected stem bases in the clump, at once produces a small bunch of somewhat abnormal fruits, some of which will contain seeds." "As a matter of fact," Barrett adds, "it is a usual thing to find seeds in the commonest of the Philippine bananas, the Saba."

The origin of the present seedless varieties is explained by many writers as a matter of simple selection, rather than of hybridization. The knowledge which we are gradually acquiring of the results of plant-hybridization, however, makes it seem plausible that some cross was the starting point from which the tropical native began his process of selection. The little knowledge we have of the agricultural skill of primitive man gives abundant reason to believe him intelligent enough to propagate choice strains of his staple crops by offshoots. In the banana Nature herself showed him the way: for in addition to seeds, which must always have been the normal method of reproduction, the banana could propagate itself rapidly by suckers —unless the primitive types were very different from those we know today. Around the base of the plant numerous small suckers are thrown up; these, it is believed, finally separate themselves from the parent, by the formation of a layer of abscission-cells, and roll down hill (when the plant is growing on a

[3]Fawcett, William. The Banana. London, 1913.

[4]Ber. Bot. Ges. XXX, 686.

[5]I owe to A. B. Stout, Director of the Laboratories at the New York Botanic Garden, the following reference: "G. Tischler, Archiv. Zellforschung 5:622-670, 1910. Tischler investigated three races of *Musa sapientum* and found that the chromosome numbers were respectively 8, 16 and 24, and that the volume of the nuclei was proportionately 1:2:3. He found irregularities in the development of pollen. Some chromosomes lagged behind and formed extra nuclei. Often eight pollen grains are formed from a single-mother cell. I believe this is all the cytological work that has ever been done on any of the bananas."

[6]Philippine Agric. Review, V, 383, 1912.

CLUSTER OF WILD, SEED-BEARING BANANAS

The fruit is concealed by huge bracts, part of which have been raised to show the "fingers." This was probably the original habit of the plant, although these bracts have disappeared in the cultivated forms, so commonly seen in fruit stores. The banana here photographed (by the Bureau of Agriculture, Philippine Islands) is known as Virgen; it is possibly *Musa glauca*, or perhaps a new species not hitherto described; natives of the Philippines propagate it, but only by seed. (Fig. 16.)

slope) until their progress is arrested by some obstacle; then they take root and reproduce their parent form.

ANTIQUITY OF ITS CULTURE.

To sum up, we find the banana established as an important crop as far back as we can see. Beccari, indeed, does not hesitate to suggest its cultivation in the Pliocene epoch, although there is by no means agreement of paleontologists as to whether Man existed as a distinct species in that epoch. In the Miocene, Beccari recalls, we find a wide variety of strange forms; in the Pliocene, we meet forms similar to those which we know today. "It is only in the Pliocene that we find forms of mammals identical with those of the present. . . . It is possible that it was in that epoch that man, clearly established as a species with the characteristics he now shows, had begun to domesticate plants and animals," and if so, we must certainly put the cultivation of the banana in that epoch: first, perhaps, as a root crop, and then as a fruit crop, when man seized and perpetuated in the plant the variations favorable to his needs, which chance inter-specific hybridization may have offered.

From the Indo-Malayan region, according to the generally received account, man must have carried the banana on his migrations, both eastward to the islands of the Pacific Ocean, and perhaps to America; and westward to India, the Mediterranean region, and finally on to America. The plant is admirably adapted for transportation over long distances, because its suckers can be dried and carried without difficulty in that condition for several months, to take root at once when placed in the deep, rich soil which they love.

Of the eastward travels of the banana from the Indo-Malayan region we have little knowledge, but its westward travels are interestingly shown by its names, with an occasional written record.

PLINY'S DESCRIPTION.

Pliny[7] is commonly held to be the first writer to describe the banana, although his account, at second hand, is inaccurate enough to have caused some doubt whether he was describing the banana or not. "There is another tree in India," he writes, "of still larger size, and still more remarkable for the size and sweetness of its fruits, upon which the sages (Brahmins) of India live. The leaf of this tree resembles, in shape, the wing of a bird, being three cubits in length and two in width. It puts forth its fruit from the bark, a fruit remarkable for the sweetness of its juice, a single one containing sufficient to satisfy four persons.[8] The name of this tree is pala, and of its fruit ariena. They are found in the greatest abundance in the country of the Sydraci, a territory which forms the extreme limit of the expedition of Alexander." The name pala is said still to be found as a vernacular name of the fruit in India, while his remark as to its being the food of the sages has given the specific name to the ordinary cultivated banana—*Musa sapientum*, "the Musa of the wise men."

As to the generic name Musa,[9] we may conjecture that it represents the name by which the fruit was received in India from its more southerly tropical home. It comes to us from the Sanscrit Moca, through the Arabic and Latin; a course that prettily illustrates the gradual dispersal of the fruit itself from India through Persia, Arabia, and Syria to the Mediterranean. The old Persian form, which represented the first transition from the Sanskrit, is not known to us. It was probably

[7]Caius Plinius, Historia Naturalis, XII, 12 (6), Rome, A. D. 67.

[8]This can not be taken too literally; yet Stanley (Darkest Africa, I, 252) mentions specimens of plantains 22 in. long, 2½ in. diameter, nearly 8 in. around.

[9]A number of authorities have given credit to the ridiculous story that the genus was named after Musa, a physician of the Emperor Augustus. This etymology is no better than the one put forth by a certain unnamed Franciscan friar who declared "chiamasi questo gentil frutto Musa, percioche le (nine Grecian) Muse usano tal cibo." As Dottor Nicolo Monardes (Delle Cose che Vengono portate dall' Indie, p. 206. Venetia 1582) justly remarks, "E cosa da muouer le risa." A legend that the banana was the Tree of Knowledge of Good and Evil of the Garden in Eden led to the name of Apple of Paradise or Adam's Fig.

A "HAND" OF WILD BANANAS

Although the seeds are numerous and fully developed, they are much fewer in proportion to the amount of pulp than in the African species shown in the frontispiece. This fruit is from Cavite, Philippine Islands, where it is colloquially known as Alinsanay. Botanically, it is probably an undescribed species. On Beccari's hypothesis, it is to be regarded as a once cultivated form, that escaped from cultivation long ago and has regained fertile seeds through cross-pollination with some distantly related type. Photograph from the Bureau of Agriculture. P. I. (Fig. 17.)

taken from Persia by the Aramaic, whose form for it would have been Moza, and the Arabs borrowed it from the latter language, as Mauz or Muz. It was spelled Musa by the Romans, and one or the other of these two forms—Muz and Musa—was the accepted English name until comparatively recent times.[10] In 1578, for instance, Lyte writes in the Dodoens (VI, 38, 704) "of musa or mose tree. The Mose tree leaves be so great and large that one may easily wrap a childe in them." Sixteenth century writers commonly call the fruit Apples of Paradise or Adam's Fig. The name banana gradually came into use in that century; it is the vernacular name given to the fruit by a tribe in the African Kongo. De Orta mentions it in 1563, while Hartwell (Pigafetta's Congo (1597) in Coll. Travels (1746) II, 553), says, "Other fruits there are, termed Banana, which we verily think to be the Muses of Egypt and Suria."

[10]C. C. Torrey, professor of Semitic languages at Yale University, kindly aided me in tracing the travels of this word.

Thus the fruit, carrying with it the name which may have come all the way from its first station in the Indo-Malayan region, reached the Mediterranean and—after the colonization of those islands—the Canaries. From the Grand Canary it was introduced to the New World in 1516, according to the very definite statement of Captain Gonzalo Fernandez de Oviedo y Valdes,[11] who heard the story "from many people." He ascribes the introduction to Hispaniola (Santo Domingo) to the "reverendo padre fray Thomas de Berlanga, de la Orden de los Predicadores"; "and from here," he continues, "it has spread to the other villages of the island, and to all the other islands populated by Christians, and has been carried to the mainland; and in every region where it has been established, it has yielded excellent results."

INTRODUCTION TO AMERICA.

This circumstantial account has always failed to satisfy a certain number of botanists, whose belief that the banana was found here long before the arrival of Columbus is based partly on tradition, more on the belief that it could never have spread so rapidly in the years following the conquest, as to account for its abundance in the many localities where it is reported by early writers; partly on the large number of distinct varieties to be found in the tropical parts of America, and partly on the finding of leaves resembling those of the banana, in pre-Columbian graves in South America. The first consideration seems to have weighed heavily with von Humboldt, who did not hesitate to declare the fruit a native of America, saying, "It is a constant tradition, in Mexico and on all the mainland, that the platano arton and the Domenico[12] were cultivated there long before Europeans arrived." Most of the botanists who have studied the subject have not considered tradition a sufficient ground for judgment: De Candolle contented himself with a verdict for "a prodigious antiquity of cultivation; in consequence, a primitive existence in Asia and a diffusion synchronous with that of the races of mankind, or even earlier."

QUESTION STILL DISPUTED.

As to the evidence afforded by the exhumation of leaves, those who uphold the Asiatic origin of the banana contend that knowledge that these leaves were really Musa is lacking, and that they were more probably leaves of some such plant as Heliconia, a South American relative. O. F. Cook has brought the case prominently forward during the last few years by championing the theory of American origin, but the majority of writers on the subject are still on the other side.

Whether the Musa, as we know it today, was actually cultivated by the natives of the Spanish Main when Columbus found them, there seems reason to believe that it or a closely related plant existed on this continent several millions of years ago. Researches of paleontologists in North America have resulted in the identification of a genus which has been named Musophyllum, and bears extraordinary resemblance to the bananas, although of course there is not sufficient evidence available to decide the exact degree of relationship. The best known of these finds in the deposits of the Eocene epoch are from the vicinity of the Yellowstone National Park. Leo Lesquereux, who described[13] *Musophyllum complicatum* as a new species in 1873, writes:

"Though the specimens representing this species are very numerous and very large, I could not obtain one showing exactly the size and form of these leaves. They appear either folded around a thick stem, from which they diverge, or on both sides of a thick rachis, extending along it like two wings, two or three centimeters wide on each side. From the fact that large speci-

[11] Oviedo, Hist. Gen. y Nat. de las Indias, Lib. XXX, cap. I, pub. in 1535.

[12] Names given by natives to two of the principal forms of the cultivated Musa. The word platano is Spanish, from the Latin platanus, and is the origin of the English plantain, by which bananas fit only for cooking are generally known. Unnatural as such an etymology may seem, it appears to be a fact that the name is due to some confusion with the oriental plane tree (Latin, platanus), wrongly called sycamore in the western United States.

[13] Annual Rep. U. S. Geol. and Geog. Survey of the Territories, p. 418, Washington, D. C., 1873.

mens are covered by fragments of these leaves crushed and folded upon one another, without any trace of middle nerves or peduncles, the leaves must have been of great size. Their substance is not very thin. The surface is perplace covered with an epidermis which shows the veins are crossed by veinlets at right angles. When the epidermis is destroyed, this character is not observable, it may, therefore, result of a wrinkling of the epidermis. The species is related to *Musa Bilinica* Ett., differing, however, by essential characteristics."

FOSSILS IN YELLOWSTONE PARK.

Fifteen years later F. H. Knowlton[14] collected the same species on the northeast side of Crescent Hill, opposite a small pond, in the Yellowstone Park, and wrote:

"This species was described by Lesquereux from a 'shale over a thin bed of coal, eight miles southeast of Green River Station, Wyoming', in what he at first regarded as the Washaki group, but which he later decided was the true Green River Group. This locality has not since been visited, and in fact can not now be satisfactorily located. It is more than probable, however, that the former determination of the horizon is correct.

"So far as I know, this is the second time this species has ever been found. It is represented by five or six fairly well preserved specimens, which agree perfectly with Lesquereux's descriptions and figures.

"On one of the specimens there are a number of thick stems or stipes. They are longitudinally striate, as described by Lesquereux, and bear only fragments of the leaves preserved. In the specimen figured we have a narrow leaf preserved almost entirely. It is about five centimeters broad and seven centimeters long, as preserved, with perfectly entire margins. In still another specimen the stipe, with portions of lamina attached, is fully 20 cm. long. There is no evidence from these specimens of the leaves having been as broad as described in some of the original specimens, but Lesquereux also speaks of narrow leaved forms."

In addition to this remnant of a remote epoch, we still have in America members of the natural order Scitaminaceae, to which the tribe Museae belongs. The most conspicuous is the Traveler's Palm (*Ravenala guianensis*), representing an interesting genus which is known to most people only by the other of its two species, the larger *Ravenala madagascariensis*. The presence of these two closely related species, one confined to the northern part of South America, and the other to the East African island of Madagascar, affords an interesting problem in the geographic distribution of plants,[15] and brings vividly to mind the antiquity of the order. Other members of the same order are the arrowroot, turmeric, cardamom and ginger plants and the strikingly beautiful Bird of Paradise flower, *Strelitzia reginae*, which is often seen in gardens in California and Florida, as well as in its tropical home.

GENUS MUCH CONFUSED.

The present distribution of the banana, then, appears to be no wider than the distribution of its order throughout its history. At present the genus Musa comprises 32 or more distinct species and at least a hundred subspecies, many of them badly confused, and many of them probably representing only the escape of cultivated varieties, or the result of natural hybridization. The Philippines and the Indian archipelago are richest in forms, followed by Ceylon; America is, by comparison, rather poor in them—a fact that has often been adduced to show that the cultivated banana was not known before its introduction by the Spaniards. The genus is divided into two broad sections: Eumusa, with edible fruits, and Physocaulis, with inedible fruits; the former is, for commercial purposes, divided into bananas and plantains, the latter being larger

[14]Monographs of the U. S. Geol. Survey, XXXII, pt. II, p. 686. Washington, 1899. Plate LXXXIII, fig. 1.

[15]Another striking instance is the well known sassafras (*S. officinale*) of the eastern United States. The only other species of its genus is found in the interior of China.

and coarser fruits which are widely cultivated in the tropics, and eaten only after cooking. The cultivated varieties are innumerable, and in confusion, partly due to their great variability and tendency to bud variation. Dr. George V. Perez, for example, has called attention to a very recent mutation of the Canary Island banana (*Musa cavendishii*) which reaches double or treble the height of its dwarf parent. The inflorescence is identical, the fruit somewhat larger and better, in his opinion, than that of the parent. It is called by the natives a "male banana." Another sport of a different nature is described from Grenada, in the West Indies, by W. Malins-Smith (Agr. News, Vol. VI): "A few days ago I picked a bunch of 'claret' bananas which contained two hands of green colored fingers and one hand of claret and green fingers There was one finger which was one-half green and one-half claret. The green fingers ripened yellow. The bunch when ripe presented a very curious appearance." There is no doubt but that a study of the plantations in the tropics would reveal an immense number of similar cases. Baker[16] mentions that *Musa fehi*, which grows widely in Tahiti, is seedless at the lower levels of the forests, but bears seeds when found at higher altitudes, say 3,000 or 3,600 feet. The sexual irregularity of the flowers also deserves attention. Altogether there is reason to believe that this genus, which has received the attention of plant breeders ever since man appeared on the earth, can yet furnish a great deal of valuable data throwing light on many of the most important problems of heredity.

[16]Baker, J. G., in Ann. of Bot. VII, 204.

Fertility of Mixed Marriages

Interesting, even though inadequate, data with regard to the fertility of mixed marriages, are given by Thomas Guevara in his work on Psicolojia del pueblo Araucano (Santiago de Chile, 1908). Dr. Rivet, reviewing it in L'Anthropologie (XXI, 590, Paris 1910), gives the following table showing the results of 58 marriages between Araucans (remnants of the ancient stock of Chile) and Spaniards, with similar data from 248 marriages between Araucans, by way of comparison. It appears, if these figures represent the true state of affairs, that mixed marriages are less fertile than those in which both parties are of the same stock:

	Marriages between Araucan and Spaniard	*Marriages between Araucans*
	Per Cent	Per Cent
Marriages without children	39.66	0.00
Marriages with 1 child	3.45	27.76
Marriages with 2 children	22.41	21.63
Marriages with 3 children	3.45	22.45
Marriages with 4 children	10.34	13.47
Marriages with 5 children	6.90	8.16
Marriages with 6 children	12.07	4.08
Marriages with 7 children	1.72	1.22
Marriages with 8 children	0.00	0.41
Marriages with 9 children	0.00	0.51
Marriages with 10 children	0.00	0.41

The

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CONTENTS

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Date of issue of this number, June 27, 1914.

HIGHLY VALUED BUT LITTLE STUDIED

Plate of fruits of the jaboticaba, natural size. Although one of the most highly prized fruits of Central Brazil, they are scarcely known to botanists in other parts of the world, and have been given little study even in their own home. (Frontispiece.)

See "The Jaboticaba," p318.

PLANT-BREEDING IN SWEDEN

Pioneer Work of the Svalöf Institute has Resulted in Revolution in Breeding Methods Throughout the World—The Theory and Practice of Pedigree Cultures—Hybridizing now being Taken Up—New Varieties Put in the Trade

H. Hjalmar Nilsson

Director of the Sveriges Utsädesförening, Svalöf, Sweden.

SINCE its foundation, the Institute of Svalöf has had the satisfaction of drawing attention, not only from the Swedish public, but from foreigners. In the course of time many accounts have also been published in technical journals, concerning its special line of work. Although they are marked by a spirit of admiration and good-will, these judgments of strangers rarely show a correct understanding of what is actually going on here, since that can hardly be known without a knowledge of the motive for the creation of this establishment, its development, and its standing in its own country.

The founding of the station at Svalöf is wholly due to the private initiative of the agriculturists themselves. Its purpose was to furnish new and improved seed to Swedish agriculture. The realization of this purpose and its development have up to the present remained under essentially the same agricultural control, in spite of the fact that the largest part of the necessary funds have been furnished by the public.

The primary and sole object of this enterprise was, then, to arrive at absolutely practical results. Scientific research was therefore only carried on in special cases, directly connected with some practical question in hand.

Nevertheless, it was fortunately understood from the beginning that only expert botanists were able to direct the variation and creation of new forms in the directions indicated, that is, to arrive at the creation of real cultural varieties, well suited to the country and more productive than those formerly in use. It was also understood that strict specialization was necessary, and that we must concentrate all our energies on this one point, eliminating all foreign activities, such as teaching, comparative field trials, commercial analyses, etc.,—activities which, elsewhere, too often weigh down the program and the staff of experiment stations.

SECRETS OF ITS SUCCESS.

It is in this unrestricted organization, with its well-selected program, its close contact with practical agriculture, and its men accessible to the latest and best methods and resources of science—it is in these points that one should seek to find how it happens that a humble provincial institution in a poor country like Sweden, under an unfavorable climate, has been able to contribute to the reorganization and improvement of plant breeding to the extent shown by the results of its work during the last quarter of a century. Another cause of its success can be found in its organization, wholly agricultural, which results from the origin indicated above, and from the character of the directors of the work.

The question of seed had been long discussed among Swedish agriculturists, when M. B. Welinder, a young farmer at Svalöf, seconded by Baron F. Gyllenkrook and many other enlightened agriculturists of the province, founded, in 1886, a local society for the improvement of seed. In a short time it aroused so much interest throughout the country, that it soon grew into the Plant Breeding

WHAT "ELEMENTARY SPECIES" MEANS.

These six forms of barley (*Hordeum distichum nutans*) were all isolated from the same mixture of types—a mixture, however, which under the old system was a commercial variety, and was sold by seedsmen as such. When the many forms in these mixed varieties are separated, distinct types or "Elementary Species" like those above pictured are found; and if they are propagated separately, each one comes true to type, forming a "pedigree culture." (Fig. 1.)

Society: "Sveriges Utsädesförening." Little by little, it received subsidies from all the Swedish agricultural associations, even those in the extreme north, and finally also from the government. At the same time, about one thousand members from all parts of the country gave it their financial and moral support.

Care had been taken from the beginning to join this enterprise with an independent association of agriculturists, in order to interest its members directly in the work being carried on, and at the same time to obtain their regular subscriptions. There are two groups of members: those who are permanent after having paid $28, once for all, and those who pay annually $1.40. A directorate of seven persons, composed of agriculturists and others interested, has charge of the administration and the finances. According to a rule adopted this year, five of the directors shall be elected by the government and two by the society itself. The society issues a periodical publication, and special bulletins when necessary. In giving advice and expert opinions, in directing comparative local trials, in examining local varieties and other ways, the society strives as far as possible to fulfil its purpose of raising the general level of agriculture in the country.

SOURCES OF INCOME.

The money necessary to carry on this work is secured from various sources.

The annual subscriptions of members give, on the average, $740 a year. The agricultural associations have contributed about $4,460 a year, and even more in recent years. Finally, the government has, ever since 1890, granted $4,200 a year and, since 1905, this subsidy has increased to $11,200. At present the yearly subsidy has been raised to $21,500; this sum includes the contributions of the agricultural associations, which will shortly be discontinued.

Finally, receipts from the sale of new creations—of which I will speak later—give a profit which has increased yearly. During the period 1901-1906 it averaged $1,450 a year, afterwards it increased to $4,400 a year, and at present it exceeds $16,000. Thus, the budget of the society for 1913 is not less than $30,000 and for 1914 $40,000.

From the payments of life members—about $10,000 in total—a fund has been set aside for buildings, much increased by donations from patrons of agriculture, which indicates the keen interest that this patriotic enterprise has awakened. The total of these donations amounts so far to $77,000.

Accordingly the society now has at its disposal a large and well-equipped establishment, comprising two connected buildings serving as laboratories, a house for preparatory work, with a little farm and a dwelling-house; it also owns 40 acres of land, of which special cultures and seed-multiplication plots occupy 25 acres. Despite this, it has been found necessary to make most of the cultural experiments on the wide fields of the huge property adjoining, in order to give the different cereals, occupying in total about 30 acres a year, their proper place in the rotation of crops, which is found absolutely necessary for a normal development.

THE DEVELOPMENT OF METHODS.

Considering that the work at Svalöf was started by farmers, and that it is the first time an attempt was made to interest theorising scientists in a question so frankly practical, you will understand that the program of work could not be otherwise than vague and fluctuating, at the commencement; it is only as the result of experience that a suitable method was by degrees found and adopted.

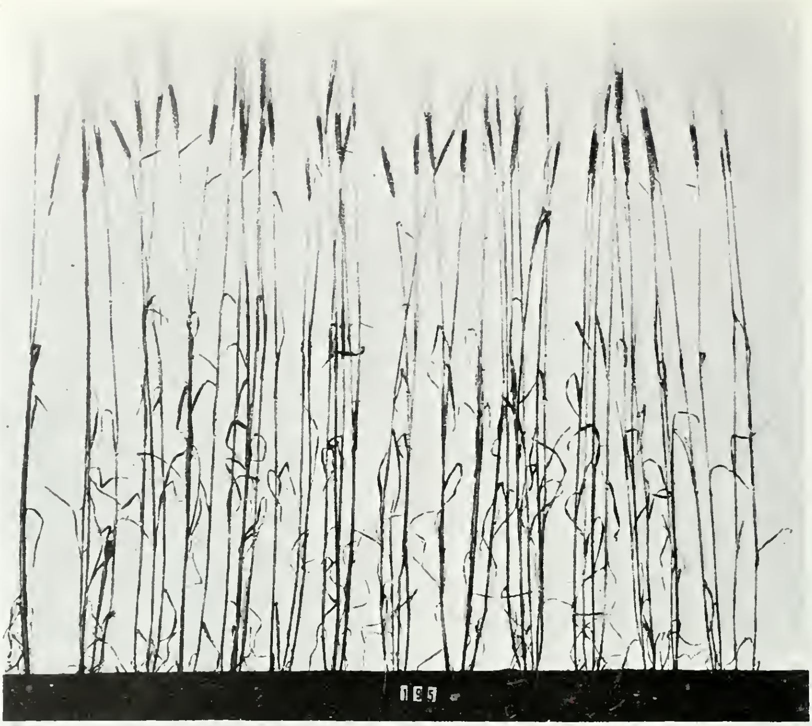
It is, then, evident that the history of this task ought to offer a picture of successive improvements, of new series of experiments, of changes and, finally, of progress; it is the more instructive because it has gone at least ten years ahead of contemporary institutions with similar purposes.

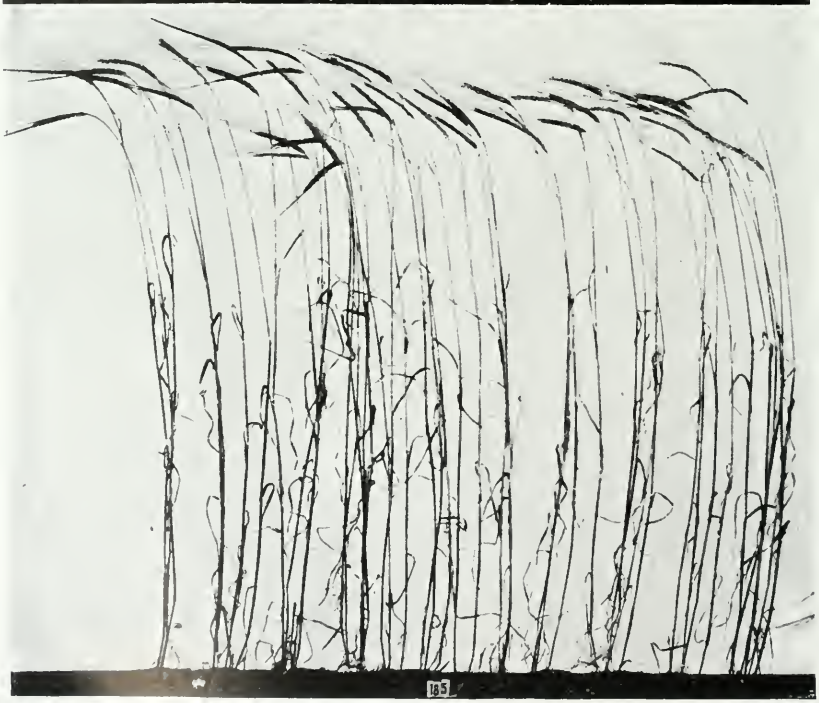
The starting point of the work was naturally the "methodical selection" accepted and practiced universally at that time, in direct accordance with the selection theory of Darwin, which was still recognized as the probable solution of the problem of the formation of species in nature.

These ideas were set forth in a way typical of the epoch by K. Rümker in his "Getreidezüchtung" (Berlin, 1889), which was looked upon, from 1890 to the end of the century, as a classic résumé of experiences relative to the question of improving agricultural plants.

It will be sufficient here to recall that we believed a methodical selection, long continued, of plants characterized by a certain common quality or disposition would lead to the creation of a new variety which would be constant and which would have exactly that quality desired as a distinctive and hereditary characteristic. The result, it was said, would be just what was seen as the result of natural selection.

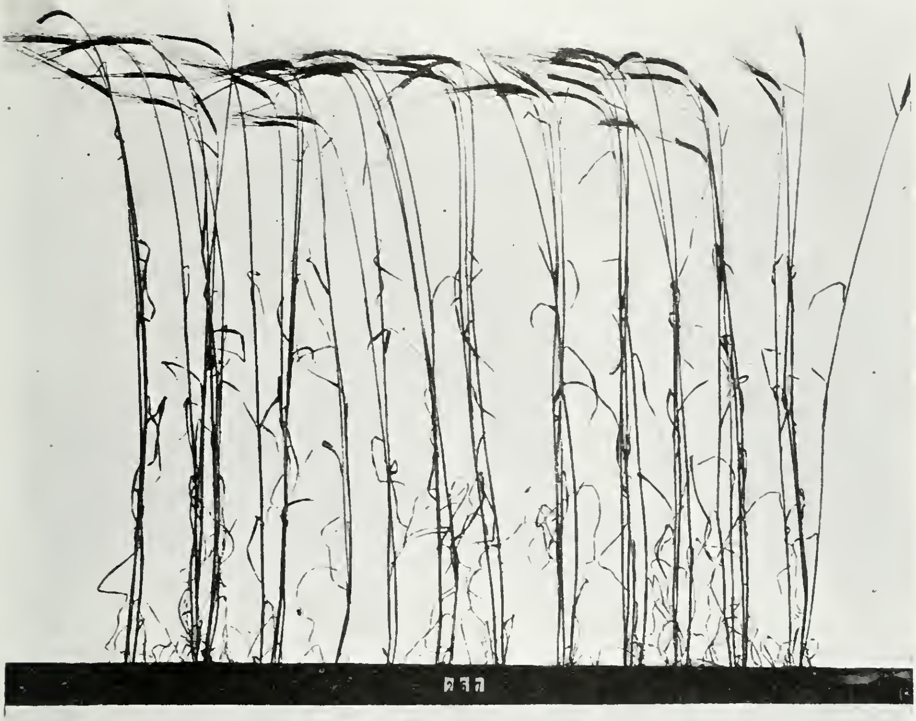
It was not until ten years later that a profound criticism of these ideas was made by Hugo De Vries in "Die Mutationstheorie" (vol. I, Leipzig, 1901), where he seriously questioned whether the progress in plant improvement which had been attained was really obtained by the method supposed, the insufficiency of which he pointed out both on theoretical grounds and by citing his own experiments. The new method of operation, by which he proposed to replace the ancient method previously employed *had at that time already been in use at Svalöf for ten years*, as we were able to prove by the hundreds of genuinely new varieties which had resulted from its application. But, because of the frankly practical

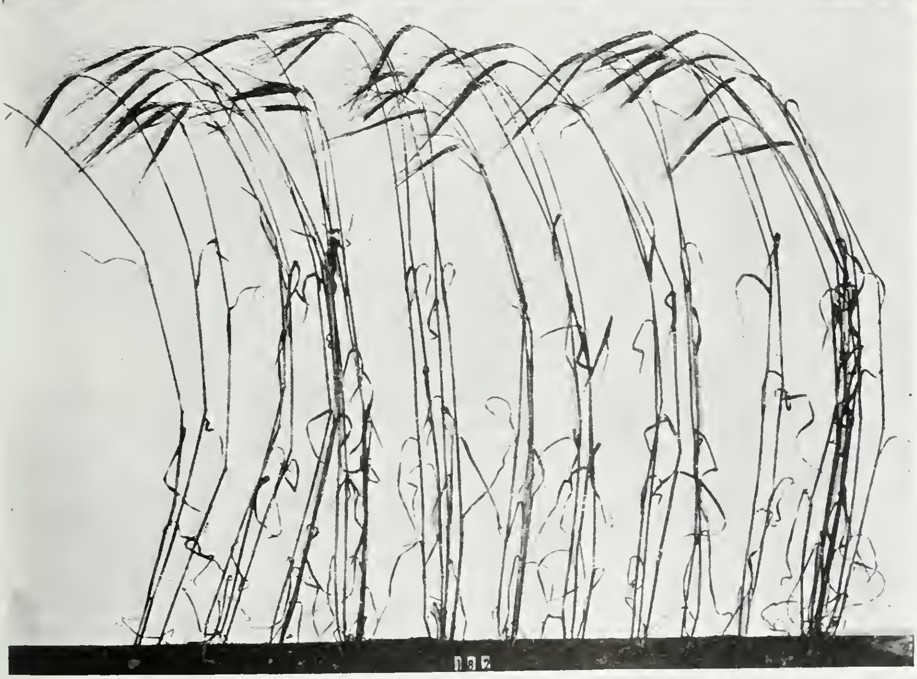




THE PRODUCE OF A SINGLE OLD SORT.

The four constant, "pure lines" of barley (*Hordeum distichum nutans*) shown on this and the opposite page, represent cultures isolated from a trade variety that has long been sold as homogeneous. A trial proved that it was in reality composed of a great number of different "elementary species," each of which, when isolated and propagated by itself, proved constant. These photographs show four types which differ widely in habit. Taken by themselves, each one can be used according to its individual value; under the old system, which existed universally up to 20 years ago, and is still in effect in many countries, these four types would have been planted mixed together as one, and the cultivator would have had corresponding difficulty in profiting from them. (Fig. 2.)





ADVANTAGES OF "PEDIGREE CULTURE"

"In employing the old method of 'selection in mass,'" says Mr. Nilsson, "we were working blindly without knowing how or when or even whether we would some day reach stability of the type, which was more important than any other quality." It is obvious from an inspection of the photographs on these two pages, showing four types differing so widely in habit and yet taken from the same old sort, that the problem was not to be easily solved as long as they were mixed together. When they are isolated as pedigreed cultures, as here shown, "all fear of failure because of insurmountable variations is eliminated. The varieties are already there, and fixed from the beginning of the work; the only difficulty is to learn to recognize them and to place the proper valuations upon them." (Fig. 3.)

character of our organization, we had been so much occupied with the practical application of our discovery that we had never had time to elucidate the theoretical question or to lay the result of our observations before the public.

METHODS IMPROVED.

It was not without deliberation that the engineer von Neergaard, the first scientific director of Svalöf, based the work on methodical selection. He simplified methods as much as possible, made the experiments more practical, replaced "approximate" measurements of certain characters of the plants by numerical valuation of weight, number, measure, size, etc. In pursuit of this aim he invented special instruments and introduced new methods of research. He was thereby able to control objectively the resulting variations and their relative constancy. Thus, methodical selection was for the first time made the object of critical scientific study, the results of which quickly appeared.

In 1890, when I became director of the work, I had to meet the desires of the authorities who were subsidizing us by making a hasty general survey of the notes which we had compiled. In spite of the extent and intensity of the selection experiments which had been made, that inspection did not show me the results which we had a right to expect. Rigorous selection pursued during five years had produced only a relative uniformity; we could not show a single new and constant variety-character. And most of all, it was evident that our selected varieties, left to themselves for a year or two, unquestionably fell back to the condition of a mere mixture of the original varieties.

Evidently, we were unable to produce what the Swedish farmers wanted—better varieties, which would be constant. It was obvious that we must find a new method of operation which would give better results.

Such, then, was the desperate situation at the beginning of 1891.

But by the summer of 1893 the difficulties had been overcome; a new method of work was in use at Svalöf, which promised perfect results in carrying out the program which the society had laid down.

During the second year of my residence at Svalöf (1889), my botanical instinct had led me to study attentively the numerous strange forms which were found among the old cultivated varieties; by planting these strange forms, would it not be possible to produce new varieties as good as those which we had tried to create by the slow and systematic improvement of the original variety?

START ON NEW PLAN.

The work was started without delay. Preparatory experiments made in 1890 with 30, and continued in 1891 with 291 different types of spring wheat and vetch had not given satisfactory results, so I increased the number to a thousand in 1892, including all the cereals, peas and vetches which we were studying. At first the result seemed none too encouraging; yet I had occasion to observe, here and there, some novel autumn wheats, which at once opened interesting perspectives to me; they represented only five per cent. of the whole collection. They showed a uniform and characteristic type, such as we had never previously found in our plantings; it was evident that they differed wholly from the rest in value. The office records showing the origin and treatment of these plots were accordingly examined, and we found that each one of these lots came from a single head of grain, or else, what amounts to the same thing, from a single plant. Our attention was by this means drawn to the importance which the progeny of a single individul has in the plant breeding. It was a novel idea for us; appreciated from the scientific point of view, it did not fail to inspire us with great hope.

In order to obtain a definite solution of this problem, we made a general experiment with separate cultures, in our 1893 planting, using 2000 different numbers and letting each number represent the planting of the seeds of a single well-marked individual plant. The result was convincing. It left no doubt as to the fact we had discovered in our

preceding work, that the only true starting-point for the fixation of different types must be plants taken one by one; the only unity with which we should work must be the living plant itself and not at all—as had thitherto been supposed—its individual organs: the ear, the grain, etc., to which different hereditary dispositions had been attributed.

SVALÖF METHOD OF PLANT BREEDING

This discovery completely changed our outlook on the problem of plant breeding, and also—as we realized very clearly—on the methods of selection. No sooner had we obtained sufficient proof than our operations were changed and immediately directed in accordance with the new principles.

In the first place we demonstrated the existence, in our material, of a large number of independent forms, having widely divergent qualities and a practical value that was quite variable. Thanks to our separate cultures, each one deriving from a single plant—"pedigreed culture"—which was easy to control, we have found that most of the descendants are constant, and only in rare cases are they in the heterozygous condition resulting from crossing. Thus, while we had formerly been absolutely incapable of producing a single variety which would really breed true, we found ourselves from then on able to produce as large a number as we pleased of new and stable sorts, suitable for extended culture.

In employing the old method of "selection in mass" and methodical order of choice, we were working blindly without knowing how or when or even whether we would some day reach stability of the type, which was more important than any other quality.

On the other hand, if we commence by a pedigreed culture, as at present, all fear of failure because of insurmountable variations is eliminated. The varieties are already there, and fixed from the beginning of work; the only difficulty is to learn to recognize them and to place the proper valuations upon them. The principal and only decisive work thus comes *after* the fixation, and when the variety is already established and in our possession.

The long series of selection-operations which we had previously been obliged to make each year on thousands of plants and for their different organs—on the plant as a whole, on its straw, on its various ears, on the haulms and on the grains—all that was now superfluous, since we recognized that the plant itself was the ultimate unity, to be treated by a comparison with all the other individuals of its generation. The ingenious instruments which had previously been indispensable in our researches have now been set aside as museum exhibits, to be used at most for an occasional control-examination: the field of experience is from now on the place for appraising our results.

THE MOST ESSENTIAL WORK.

It will be understood, also, that although this simple operation created a complete revolution in our methods, pedigree-culture has nevertheless received only a secondary place among the operations at Svalöf. It has become only a preparatory and practical auxiliary for getting out properly the material which we desire to utilize. The greatest interest and the most essential work, on the contrary, remain in further investigation of the practical value of the innumerable little elementary species.

The decisive qualities of each species being surprisingly numerous, and combining with each other in related forms according to a fabulously rich scheme, the determination of their comparative values becomes an extremely arduous task, the more so since it is necessary to start with as large and varied a collection as possible, if we want to have a chance really to find the best. Accordingly, since that time the principal work of Svalöf has been connected with these problems. That is why it has become so preponderant, why it has stamped its character on the whole system at Svalöf.

The first thing to do was to divide up the work among the competent persons available, in such a way as to give to each one a limited field, comprising one

THREE TYPES OF TIMOTHY

Under the old system of seed production, a commercial variety containing all three of these sorts of timothy (*Phleum pratense*) would have been given to the farmer, in spite of the fact that they differ so widely in habit and blooming time. Under the modern system, the commercial material is sorted out (by actual planting tests) and each component part isolated, and made to stand on its own merits. (Fig. 4.)

or two cereals. Then, by profound study of his own material, by rigorous research and field trials, each one was able to become an expert in his special branch, training his eye to distinguish first of all the different forms, and next the relative value of existing characters.

Thus prepared, we became able to establish an exact systematic classification of the different species, the only means applicable to obtain a comprehensive survey necessary to the study of polymorphous material. The first comparison was between the groups thus limited, and the second an examination of the different sorts inside these groups.

The fact that we have usually succeeded in making natural systems out of these classifications, where char-

acters which are clearly morphological indicate to us the absence or presence of qualities determining the practical value, is an advantage which can not be overestimated. It makes it possible for us to make some progress, at least, toward the desired goal, from the moment that the first generation is examined.

THE USE OF PRACTICAL TRIALS.

For the final and decisive determination of agricultural value, we have had on the contrary to depend on practical trials. It was thus a great advantage to our Institute to have a strictly agricultural organization and equipment, due to its close relations with practical men. It is solely the progeny of these "élite" parents, cultivated in an ordinary field under normal agricultural conditions, that determines the practical value of the inherited qualities of the numerous new forms. To reach the final decision, cultivation and careful examination during a long series of years are ordinarily necessary.

In order to be able to apply all these processes with exactitude, and with the order necessary when thousands of forms are dealt with (in 1912 there were more than 9500 numbers in our trial grounds) we have had to invent numerous practical arrangements. We have had to establish special genealogical tables, corresponding to the systems of fixed forms, with a numerical arrangement applying to the parallel genealogical collections which we made, as well as to the trial grounds, the records, the labels, etc. The interior arrangement of the work rooms, and the whole organization of the laboratories, had also to be on lines which were absolutely systematic and easily inspected. We have reached the point where we have at Svalöf an establishment that is probably unique in its complete adaptation to its own method of independent work. Our institution and our method thus comprise, together, a unity which promises to perpetuate both our special system and the intensity which has always marked our application of it.

In its broad outlines, this order of work was established in a very few years; so we were able to demonstrate its operations for the first time at the general congress of Swedish agriculture in 1896, by several hundred varieties which were new and stable, and under comparative observation. During the course of our work it was also obviously stated how numerous and decisive the lines of progress were which we had already utilized practically for the benefit of Swedish agriculture, before it had been even realized in other places what we were trying to do.

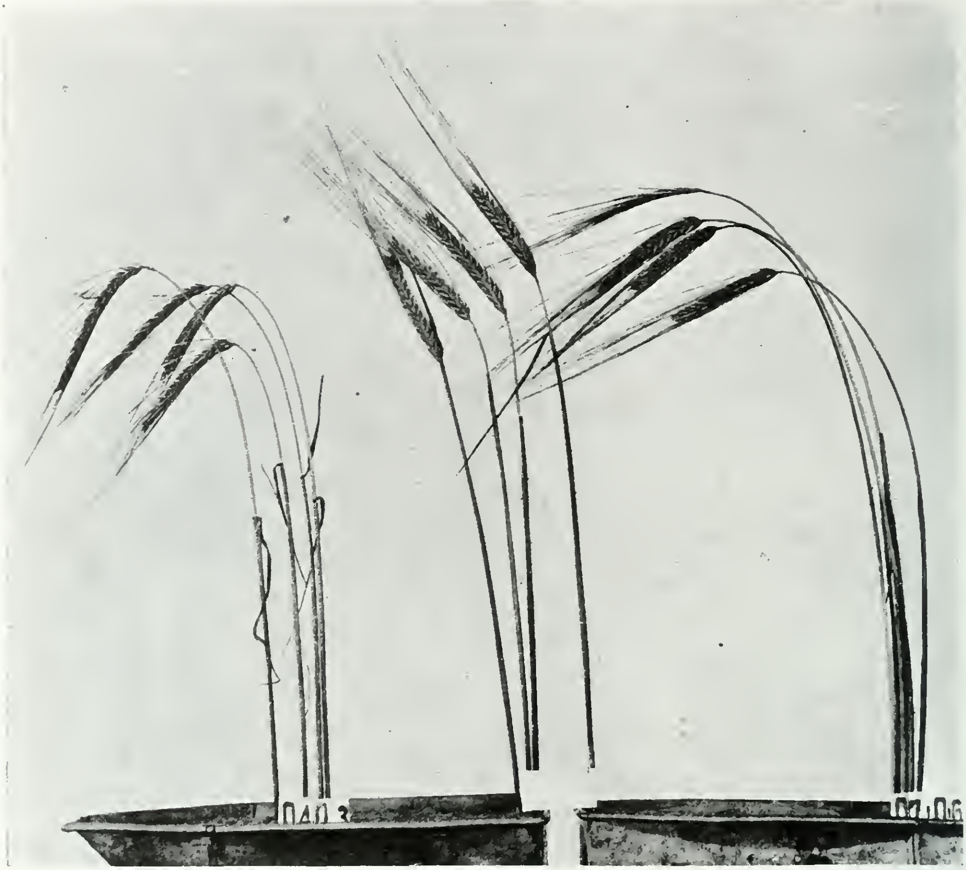
WORK ON WIDE BASIS.

By the infinite number of stable forms which with this came to light in our culture material, the amelioration of economic plants had a basis far wider than the old method could give, with its limited number of chosen varieties; the possibilities of producing valuable novelties were increased, because the qualities at our disposition varied widely, and among them—as our experience soon showed—are included the season of maturity, cold-resistance, disease-resistance, etc., qualities which are of a great practical value, but which had previously been quite inaccessible to the work of plant breeding.

Since the forms which we regard as varieties are systematic and independent unities, although of secondary order, the fact that they breed true considerably extends their possibilities, for they can be propagated without the necessity of renovation too often by the purchase of new seed.

The constancy which distinguishes them concerns many characters and qualities, as to whose transmission we had never dared to depend. As it persists in a notable degree among all the plants—at least, during the early generations—whatever there is in the variety in question of a particularly inheritable nature becomes more obvious than before, a circumstance which greatly facilitates the expertising and the control.

It is very true that the most specialized kinds demand more judgment and care on the part of the cultivator, but they equally increase his chance of as large a financial profit as possible, when he has learned to make a judicious



SUCCESSFUL BARLEY HYBRIDIZATION

In the center is shown a new and constant form of barley with stiff, erect ears, which resulted from a cross between two very "nutant" old sorts: *Hordeum distichum nutans* (at the left) and *H.d.erectum* (at the right). Hybridizing experiments on an extended scale at Svalöf only date from the beginning of this century, but it is evident that much of the future progress will be by that means. (Fig. 5.)

choice among the strains, in accordance with local conditions. Considering the keen competition of our days, this judgment becomes more and more a vital question for modern agriculture.

It is especially for the people of the North, who, because of their climate, their isolated situation and the varied character of their soil, can only rarely get their seed supply from more favored countries—it is for these people that a method of selection, based on the very heterogeneity of the material, necessarily must have an inestimable value. It is only by this means that we shall be able to use the eventual values of our old, native races; inferior as sorts, they nevertheless offer, by their most serious defect—polymorphism—exceptional chances for the selection of a better variety.

With the same motive, we can handle the species and native races of all countries by this method, no matter from what climate they come or what their nature may be, for we everywhere find a diversity of forms offering ample room for selection.

INSTITUTE REACHES ITS GOAL.

In establishing this method of work, the order of procedure in which has been reversed, since the valuation of qualities is made on varieties already

fixed and with the aid of the auxiliary associations whom we serve, we may say that the Institute of Svalöf has reached its essential and peculiar goal, and that it has attained for itself a memorable and incontestable place in the history of plant improvement. Following its example, all analogous contemporary operations have successively passed from selection in mass to the utilization of the qualities of hereditary character, studied on an isolated plant, although sometimes under different names, such as "individual selection," "selection by families," etc. Separate culture and separate judging have also been, and still are, conditions necessary to the practical application even of discoveries made later concerning the value of different qualities as mobile, hereditary units.

I would certainly not wish to be understood as saying that propagation of separate plants had not previously been made by cultivators like Shirreff, Vilmorin and Hallet. But it is certain that not one of them, not even Vilmorin, had ever realized such great possibilities of this simple procedure, as we had discovered and applied in practice here at Svalöf 20 years ago.

Furthermore, their experiments in this direction were, at the beginning of our experience, so completely forgotten and ignored in practice, that it was necessary for us, as I have already said, to discover the fact anew.

The reader may well ask of what nature are all these little elementary species, which have allowed the old material to be sorted out into independent new sorts? Do they come from mutations, from natural cross-pollination, or from both together?

It is a fact well authenticated at Svalöf that mutations appear from time to time in our cultivated plants. Furthermore, we have found that spontaneous fecundation is much commoner than we had supposed. But it must not be imagined that we can discover with certainty, in each particular case, the origin of all the forms—and anyway, the knowledge of how they originated does not trouble our practical work, for which the fact of their existence is sufficient. Finally, it must be noted that the significant results furnished by diverse methods of origin are the same in the two cases, that is to say, they lead to the possession by each group of a multitude of systematic unities, differing from each other in the way their characters, often few in number, are combined. They are all what have been called "minute species" or "elementary species." Mr. Johannsen, who later examined them carefully, has described them as "pure lines." Here we have retained for them, for practical reasons, the English name of "pedigrees."

IN CROSS POLLINATION.

Although we did our first work of this kind with self-pollinating species (wheat, barley, oats, peas, vetch), we have later, in dealing with rye, clover, forage grasses, beets, etc., had occasion to convince ourselves that the existence of these small species, quite analogous, is clear in plants which are not self-fertilized. With these, of course, we do not find the pure lines immediately upon isolation. They require systematic treatment during some years, to offer a satisfactory degree of purity and stability, which even then can never become so perfect as among self-fertilized species. But it is already proved that by the aid of such forms we can reach the same practical results as by the aid of the elementary species. The extension of Svalöf Institute has as its principal object to make the treatment of these groups of crossed lines more intense by the fixation of the forms, followed by their careful valuation.

Among the means of securing new forms of cultivated plants, I must also also mention artificial hybridization. About 20 years ago, when we were entirely occupied in profiting from the precious forms which an exploration of our old varieties had given us, we had no chance to study this method seriously. Furthermore, the extended experiments with cereal-hybridization which we made some years later (1897-9) did not give encouraging results. Nevertheless, the fall wheat Svalöf Extra Squarehead II, finally so famous, dates from that first series of crossings.

MENDELISM IN OATS

In the upper row are Svalöf's Klock Oats II (at the left) and Svalöf's Stormogul Oats (at the right). Each of these "pure line" sorts has one mendelian factor which causes spreading panicles. The factor in Klock Oats (A1) is, however, distinct from that in Stormogul (A2). When the two sorts are crossed, the genetic formula will be A1a2 x a1A2, capital letters denoting presence of the factor for spreading panicles, and small letters absence of it. When the factors are distributed and combined in the germ-cell, one combination will arise lacking both positive factors, and represented by a1a2. As this oat will lack altogether a factor to spread the panicle, its appearance will necessarily be quite different from that of either parent; as a matter of fact it grew up to be a "sideway panicle" oat, shown at the right in the lower row. Another combination of the factors brought both positive factors (A1A2) together in the same cell; and the oat with this "double dose" of spreading-panicle factor appears to be even more spreading than either parent. It is shown in the lower row, at the left. The rest of the oats from this cross were represented by the factors A1 a1 or a2 A2—that is each possessed one factor for spreading. These two types, when grown, were indistinguishable, and looked about like their parents, as shown in the center of the lower row. (Fig. 6.)

Gradually, as we obtained a large enough collection of new and well-known lines, characteristic and stable, each one with a superior quality of practical worth, it was natural for us to seek to obtain still more valuable combinations among these qualities by hybridization experiments, well planned and systematically executed. That is, accordingly, what we have had in hand since the commencement of this century.

HYBRIDIZING IMPORTANT.

Since the researches of Mendel, so fundamental for the study of hybridization in general, have again become accessible, this sort of work has been much increased at Svalöf. It is especially by the widely-known studies on oats and wheat of Dr. Nilsson-Ehle that remarkable contributions have been furnished by actual investigation of the phenomena of this category. The new light thrown by them on the problems of heredity and variation has a really great influence on improvement. The new laws which teach us to think of the different characters of the plants as behaving like autonomous unities from the very beginning, are also important in our work.

It is incontestable that these discoveries still further increase the possibility of progress. It appears that, particularly in Sweden, it will finally be possible for us to create by this means an agricultural material adapted to the most northern latitudes, which will add to general good qualities a greater cold-resistance or earlier maturity.

However, the application of this method in a widespread way at Svalöf shows that the combination and breaking-up of qualities, ordinarily very complicated in products of hybridization, makes very illusory the hope of reaching results based solely on theoretical calculations. That is an inconvenience which we must endure, however, since hybridization offers so many chances, even if they are vague, which we could not otherwise obtain.

In any case, hybridization as we practice it at Svalöf with our varieties already fixed, must be considered only as a supplement of our original method of selection in pure lines, and not at all as replacing it. Every hybridization experiment demands as starting point a pure and constant material with well-known qualities—consequently, that is what we must first produce. Besides, the final evolution of the process of hybridization depends on the continual creation of new material superior to that which preceded it. To produce these two types of indispensable material, we must continue to employ our method of selection, which is the best and most efficacious for the discovery of the most precious and most constant components in the old, mixed varieties. In addition, selection in the extremely variable products of hybridization is practiced indiscriminately with the older style of selection in our work at Svalöf.

Although the Institute of Svalöf has already given, and probably will still give, as rich contributions to Mendelism as any of its contemporaries, it must never be forgotten that its main work, its specialty, will always be the hunt for novelties by its own, original method, which must never be set aside in favor of the other work of improvement following this. Furthermore, for a large and important part of the material treated, such as the forage plants and root crops, the time for hybridization will only arrive in the distant future.

GROWTH OF THE WORK.

The crops dealt with at Svalöf have been fall and spring wheat, rye, barley and oats and also, since 1889, peas and vetch. Oats were, however, not given intensive study until after the adoption of the new method in 1893 and rye only in 1900. The original program included other crops, but these have had to wait until larger subsidies are available. It was not until 1905, when the government made an allowance of $7,000, that we were able to take up the improvement of forage crops, clover and potatoes. The root crops have not yet received any keen attention, although they will be given it as soon as the financial reorganization, of which I have already spoken, is completed. It is true

that they have been studied, for some time, but principally after the simplest pedigree method and by selection in mass. With these, all the Swedish crops will have become the object of improvement at our institute.

As I have already remarked, the intensive studies which our new method necessitated led to a division of labor in such a way that each specialist received a limited field for which he was responsible. Thus I took charge of oats and wheat in 1890, and in 1899 turned them over to Dr. H. Nilsson-Ehle. P. Bolin had barley from 1892 to 1896, when he was replaced by Dr. H. Tedin, who since 1892 has also had charge of the Leguminosae. J. Walldén was in sole charge of rye from 1901 to 1904 when he divided it with E. Ljung, who since 1908 has been in entire control of it. Dr. Lundberg has worked with the potatoes since 1905; forage plants were taken by me in 1904, but turned over in 1907, with clover, to Dr. H. Witte. Root crops have been handled since 1907 by I. Karlsson. Mr. Walldén has directed the work of controls and germination since 1892.

It is evident that the final results have no practical value except in the same conditions under which the experiments were made, and that a change of climate and soil might entirely change their value. In a country like Sweden, which extends over thirteen and two-thirds degrees of latitude, that is to say, over a distance from north to south as great as that from our south coast to Rome, it is absolutely necessary to make numerous tests in different parts of the country. As soon as we had produced at our institute, situated in southern Sweden, a large number of varieties which we thought suited to the central part of the country, we began to arrange numerous local trials each year. Soon we had to form special branches, in order to make serious and properly-directed tests. We have now two branches, one since 1894 in central Sweden, near Upsal, and the other near the arctic circle at Luleä, which was organized particularly for the study of forage plants. Our plans contemplate the creation of other branches in the most important agricultural provinces.

NEW VARIETIES OBTAINED.

As I have already pointed out, the Swedish agriculturists, in founding their breeding station at Svalöf, intended principally to obtain new varieties suited to their country. In passing judgment on the work of the institute, it is therefore necessary to limit one's self to a consideration of the varieties put in the trade, and their success.

First, it can be said that our varieties have become established throughout the country to a surprising extent. In the principal agricultural districts, and for certain cereals, they have almost entirely supplanted the old varieties, as well as those later introduced from abroad. The only explanation of this is that the institute and its specialists have always kept in the closest touch with the farmers, who are, in fact, in a majority on the directorate. Thus the real needs of the farmers were known, and the attempt to supply them has always been the guiding principle of the work. It has been our principle and practice to introduce into the trade as few varieties as possible, letting nothing go out that was not absolutely superior. However, the wide range of climatic, cultural and industrial conditions has made it necessary for us to furnish a group of varieties of each cereal, rather than a single superlative one. I can best make this clear by surveying the varieties of Svalöf origin which are now actually in the trade; but it must be remembered that some sorts placed on sale, although meeting with public favor, have been withdrawn when it was possible to replace them with a variety of the same type but better quality.

TWO SERIES OF WHEAT.

There are two series of fall wheat, one for the southern provinces, where the climate is favorable and we have bent our energies to producing varieties with large yield (*Grenadier*, *Extra Squarehead* II, and *Sol*), and the other for the more rigorous climate of the central provinces, where cold-resistance was the

ORIGIN OF A GRAY LINE OF OATS

The principles of Mendelism were prettily exhibited in a cross of black and white oats (shown in the top row, above). The first generation was all black, like one of the parents; it is shown as a single seed in the middle row. The second generation, shown in the lower row, segregated as was expected into the Mendelian formula: 12 black, 3 gray and one white. The genetic explanation as given by Dr. Nilsson-Ehle is that the black parent strain (BG) had one factor for black (B) and also one factor for gray (G); but the gray color was covered by the black. The white sort, of course, lacked both black and gray, and is therefore represented by the symbol bg. Among the possible combinations of factors in hybridization, is bG, the plant of which will lack the black factor but possess the gray: its color, then, will be pure gray, without any trace of overlying black, just as is shown in the three seeds of the lower row. The one white seed is known as the "extracted recessive"; according to the prevailing theory, it is white because, lacking factor for either black or gray, it could not be anything but white: in other words, it is a mere case of presence or absence of color, which is shown to be heritable by purely mathematical formulae, based on the Laws of Chance. (Fig. 7.)

preëminent requirement (*Renodlad Squarehead*, *Bore*, *Pudel*). In the south our varieties have already supplanted the native ones, but in the center, the old ones are still much employed, since we have not wholly gained the hardiness necessary. From our new series of hybridizations we hope to produce the ideal. For spring wheat in that latitude an early maturity is the prime requisite, and we can point to great progress in that direction (*Pärl*), but still have some hybridizations to make with the native varieties before attaining perfection.

As for barley, the breweries have dictated the qualities needed, not only as to general good quality (*Chevalier* II) but also for the amount and stiffness of straw (*Prinsess*) and for precocity (*Hannchen*, *Gull*) which allows culture in the more northern provinces. A second group is composed of varieties adapted to solid, moist soil, and satisfactory for brewing (*Primus*) as well as for forage (*Svanhals*).

In oats we have to meet the needs of certain provinces which require black varieties early (*Fyris*), with stiff straw (*Klock* II) or late, productive sorts (*Stormogul*) and on the other hand, to satisfy the demand for white or yellow varieties, yielding heavily although rather late (*Seger*, *Kron*, etc.), and others more precocious for northern provinces (*Guldrägn*, *Dala*). In order to meet the requirements of provinces still further north, where oat growing is still important, we have had again to fall back on hybridization, and have already made enough progress to inspire us with great hopes.

In rye, we have combined high yield, great hardiness and good commercial quality (*Stjärn*).

As for peas, we have produced both the kitchen varieties (*Concordia*, *Kapi-*

tal) as well as forage varieties for use in ripe state (*Gröp*) and as green fodder (*Solo*.) In vetch, there is need of varieties for fodder, and for seed (*Grä* and *Sät*).

Among the forage grasses, we possess various varieties taken from early, medium and late wild forms to produce meadows of uniform development. Here the natural flora of the country has furnished us material far superior to that of the tradesmen. In dealing with clover, we have principally utilized the indigenous varieties, which are perennial, hardy and highly productive. Our demands in respect to potatoes differ widely from those of the continent, since the alcohol industry is highly localized here. In general, however, precocious varieties are required.

Finally, it is universally admitted that the society has contributed in many other ways to the progress which Swedish agriculture has made during the last twenty years: for example, by its propaganda in favor of more scientific agriculture, by its advice and directions, its demonstrations, field trials, etc., but most of all in raising the standards of the seed trade throughout the country, an elevation made possible by its control of the wholesale trade of its own sorts. By all these means, the real value of the perfected seeds has been made known, and the farmers have learned to raise their demands to an extraordinary height.

OUR INFLUENCE ABROAD.

As we have seen, the Institute of Svalöf was founded by Swedish farmers to serve their common interests. In organizing and achieving this task, therefore, the society had in view, as it still has essentially in view, only the needs and possibilities of Sweden. Furthermore, it is obvious that varieties selected for their adaptation to as peculiar and northern a climate as ours would be valuable only to a limited extent in a country with different physical conditions. Nevertheless, in so far as concerns the continent of Europe north of the Alps, excepting central Russia and certain parts of Austria, it seems that a considerable number of our productions are well adaptated to foreign conditions. Accordingly, they have been propagated there to by no means an inconsiderable extent. It has been proved that varieties like the barley *Hannchen* and the oat *Guldrägn*, maturing early, have accommodated themselves to an unexpected degree, even to extreme conditions.

Thus, to cite only a few examples, the new oats are widely employed and much appreciated, particularly in Russia. Most of our varieties are much cultivated in Germany, Denmark and Holland, and more lately in England. In France our brewing barleys, and also our oats, are regarded with great favor. In Canada and the United States many varieties are in use, in definite and circumscribed areas. And in all the rest of the world isolated experiments have been made with our productions, under the most diverse conditions, and with the most diverse results, as was to be expected.

Beyond this, it becomes daily more evident that the method of organization of plant improvement which was originated at Svalöf has been studied by practically every civilized country and adopted as a model. The questionnaires which arrive from all directions, and the frequent visits of specialists of all nations, are sufficient proof of this foreign interest.

But I would be going too far, if I entered into a discussion of this subject. Let me conclude by recalling that selection in mass, which was generally employed even ten years ago, is at present abandoned. Both young and old breeders have now adopted the plan of separate culture, starting with single plants—that is to say, the very principle on which we established here at Svalöf, in 1893, our new method of plant improvement.

Second Report of the Committee on Immigration of the Eugenics Section of the American Genetic Association

Alexander E. Cance, Amherst, Mass.
James A. Field, Chicago, Ill.
Irving Fisher, New Haven, Conn.
Prescott F. Hall, Boston, Mass., Chairman.
Robert DeC. Ward, Cambridge, Mass., Secretary.

THERE has been one change in the membership of this Committee since the last report, Professor Franz Boas having left the Committee and Professor Irving Fisher, of Yale University, having taken his place.

A second year of study of the problem of immigration on the part of your Committee has resulted in a renewed and more profound conviction of the necessity of arousing intelligent and unprejudiced public opinion in this country to the need of strong and concerted action in favor of a more effective immigration law.

We have hitherto left the choice of the fathers and mothers of the future Americans largely to the selfish interests which care very little whether we want the immigrants they bring, or whether these people will be the better for coming. Steamship agents and brokers all over Europe, and even in Asia and Africa, are today deciding for us the character of the American race of the future. The steamships and railroad companies, and the large employers of cheap labor, have vast financial interests at stake. They want unrestricted and unselected immigration. They are well organized, and have very great influence in Washington. None of these "interests" care in the least for the sanity or for the physical soundness of our race. If their pocketbooks are well filled they rest content.

To counteract these influences and to point out wherein our immigration laws need strengthening for the better protection and preservation of the race is a duty which the American Genetic Association may well take the lead in performing.

This Committee finds that, in spite of the present law which prohibits the admission of insane and mentally defective aliens, our institutions are filling up with these very persons, and what is still more serious, there is a rapidly increasing number of mentally defective aliens at large in our communities, in no way segregated, and free to reproduce their kind. Abundant evidence and statistics of the serious conditions which now exist, and are rapidly becoming worse, is contained in the *Report of the Committee on Inquiry into the Departments of Health, Charities, and Bellevue and Allied Hospitals in the City of New York* (1913), and in the *Report of the Special Commissioner on the Alien Insane in the Civil Hospitals of New York State* (1914), to which this Committee would call special attention. It appears that while the foreign-born in 1910 constituted 30.2% of the entire population of New York State, the foreign-born insane constituted 43.4% of the patients in the State hospitals Sept. 30, 1912. Furthermore, there is a gradual decrease in the native-born percentages of the admissions and a corresponding increase in the foreign-born percentages. Dr. Spencer L. Dawes, the Commissioner on the Alien Insane, says, "If the increase in the percentage of the foreign-born be continued at its present rate for about 10 years longer, the foreign-born admissions will equal in numbers the native-born." Dr. Dawes points out very

clearly the defects in our present immigration law in the matter of the admission and deportation of alien mental defectives, and suggests the amendments necessary to improve existing conditions. Many of these proposed changes, this Committee is glad to note, have been adopted by the Committee on Immigration of the United States Senate, and are included in the Immigration Bill which has been reported to the Senate. Dr. E. K. Sprague, of the U. S. Public Health Service, has estimated that probably only 5% of mentally defective aliens who come to our shores have been detected, and about 25% of those who are or who will become insane. This Committee is entirely in accord with Dr. T. W. Salmon, also of the U. S. Public Health Service, and now Director of Special Studies of the National Committee for Mental Hygiene, when he says: "There is no reason for the acceptance of a single insane or mentally undesirable alien except inability to determine his condition. This does not require restriction of immigration, but a sensible selection of individual immigrants, in the interest of our own country and wholly without reference to the interests of foreign countries or foreign steamship companies."

SENTIMENT BEING AROUSED.

Each year brings increasing evidence that those who are most concerned about the maintenance and the improvement of the physical and mental well-being of our race are turning more and more to the regulation of immigration as one of the most obvious means of accomplishing their purpose. Thus, in the *Report of the Committee to Study and Report on the Best Practical Means of Cutting off the Defective Germ-Plasm in the American Population* (Eugenics Record Office, Bulletin No. 10B, 1914) we note the following: "The Federal Government must co-operate with the states to the extent of excluding from America immigrants who are potential parents and who are by nature endowed with traits of less value than the better 90% of our existing breeding stock." . . . "The Federal Government which has control of immigration owes it . . . to the American people on biological grounds to exclude from the country this degenerate breeding stock."

A serious situation which arises from the non-enforcement of the law for reasons of "sentiment" and of "humanity" deserves attention. No one who is not acquainted with existing conditions can possibly realize how strong, how steady and how effective is the "pull" which is exerted by the families and the friends of aliens who by the laws of the United States ought clearly to be debarred, to have those aliens landed. The steamship companies; the societies to which the alien's relatives belong; sentimental but woefully misguided "philanthropists," and Senators and Congressmen who are trying to please their foreign-born constituents—all these interests unite to bring pressure to bear upon the immigration officials to whom appeals are referred. Obviously, the oftener such appealed cases are admitted, the more lax does the preliminary inspector tend to become, and the less frequently do the Boards of Special Inquiry, in the first instance, recommend deportation. Those who want our incoming aliens to be sane and sound and fit ought to stand behind every honest immigration official who does his duty well; and ought to see to it that there is no relaxation in the enforcement of our laws, to the detriment of the race. Former Immigration Commissioner Williams well said: "We are not called upon to endanger the future of our country or its institutions for the sake of the distressed of other countries, however much their condition may arouse our sympathy. The time has come when it is necessary to put aside false sentimentality in dealing with the question of immigration . . . and in determining what additional immigrants we shall receive to remember that our first duty is to our own country." Another has stated the case thus: "These (immigration) authorities should be made to understand that in their attempts to be kind to the immigrant they may be cruel when they help to fasten upon this country a never ending burden of the care of a mentally defective strain for which we as a people are in no way responsible."

Under the vote of the Association by which the Committee on Immigration was organized, it was given "authority to co-operate with similar Committees of other organizations in securing laws which will be more effective in securing immigrants who bring good health and normal and superior heredity to this country." Following these instructions, the Secretary of this Committee attended a Conference held in New York City, Nov. 15, 1912, at which the most important scientific bodies in the United States which deal with the treatment and prevention of insanity were represented, viz.: the American Medico-Psychological Association; National Committee for Mental Hygiene; New York Psychiatrical Society; New York State Charities Aid Association; Committee of 100 on National Health; New York State Hospital Commission. At this conference the whole question of the more effective detection, exclusion and deportation of insane and mentally defective aliens was discussed. The results of these deliberations were embodied in a series of Resolutions which were transmitted to the President and to Congress. The Immigration Bill which passed Congress during the winter of 1912-13 embodied several of these recommendations. Two members of this Committee (Messrs. Hall and Ward) went to Washington to attend the hearing which was given by President Taft on the Immigration Bill, and urged that the Bill should become a law. The President, as will be remembered, vetoed the bill, which was at once passed over the veto by the Senate (72 to 18) and failed by half a dozen votes of being passed over the veto by the House.

ATTITUDE OF EUGENISTS.

The Chairman and the Secretary of the Committee have further carried on a considerable correspondence, and had many conferences with immigration and other public officials, and officers of the Public Health Service, in regard to the workings of the present law, and have also given numerous addresses on the eugenic aspects of immigration.

In the present agitation concerning pending immigration legislation the question naturally arises what attitude those who are most interested in the eugenic aspects of alien immigration should take in regard to any proposal for a further *restriction* of immigration by means of such a requirement as the "reading test," embodied in the immigration bill which was vetoed by President Taft. It is clear that the sentiment in Congress is strongly in favor of combining more effective regulations in regard to the mental and physical condition of our incoming aliens with a further amendment which will be somewhat restrictive. When a further restriction of immigration is recommended, because "demanded by economic, moral and social considerations," by an unprejudiced and competent body of experts like the U. S. Immigration Commission, eight out of nine of whose members recommended the "illiteracy test," and by Congress, as evidenced by the large majorities in favor of such measures, then we must have very excellent reasons for disagreeing with those conclusions. A decrease in numbers, especially of those aliens who are unskilled laborers, and who are the most ignorant, will have a very important and direct eugenic result in relieving the congestion in our overcrowded cities; in diminishing economic stress, and therefore in improving the mental and physical conditions of the aliens who come to us. The more skilled and the more intelligent the alien, the less he tends to crowd into our cities; the less liable he is to become insane or mentally unstable from the strain and stress of the life in our congested city districts. Dr. T. W. Salmon has clearly pointed out that 'More will be accomplished in the exclusion of insane immigrants, and of those destined to become insane a short time after their arrival, by measures which broadly restrict immigration than by any measures, however effective, which are directed specifically against insane immigrants, for any measure which will check the flow of immigration in general must necessarily result in the admission of fewer undesirable immigrants." Those who are particularly interested in the eugenic aspects of our immigration problem have many reasons

for joining hands with those who have the economic aspects of it most at heart, in the campaign for the better regulation of alien immigration to our sho es. This committee, however, has not deemed it within the scope of its own work to consider the economic aspects of our immigration problem.

On Feb. 4, 1914, the House of Representatives by a two-thirds vote, passed an immigration bill (H.R. 6060) which is essentially the same as that which was vetoed by President Taft. A similar bill is now before the Senate. Regarding the present legislative situation a majority of the Committee has agreed upon the following resolution:

Resolved: That the Committee on Immigration of the American Genetic Association respectfully urges upon the Senate of the United States the importance of the passage, at the present session of Congress, of an Immigration Bill similar to that which passed the House of Representatives on Feb. 4, 1914 (H. R. 6060), embodying provisions which, if enacted into law, would unquestionably result in a more effective detection, exclusion and deportation of mentally and physically defective aliens, and in a general improvement in the character of our immigration.

Resolved: That copies of these resolutions be sent to the President of the United States, and to the members of the Committee on Immigration of the Senate.

(Signed)

Alexander E. Cance, Massachusetts Agricultural College, Amherst, Mass.
Irving Fisher, Yale University, New Haven, Conn.
Prescott F. Hall, Boston, Mass.
Robert DeC. Ward, Harvard University, Cambridge, Mass., Secretary.
April 24, 1914.

Association Meeting in August, 1915

Pursuant to an invitation from the American Association for the Advancement of Science, the American Genetic Association will hold its next annual meeting in connection with the meeting of the American Association at Berkeley, California, in the week of August 2–7, 1915. The program of the American Genetic Association will occupy a number of half days, to be selected later. Details will be in charge of the chairmen of the three committees on research.

International Genetics Conference

September, 1916, has been set as the date for the next International Genetics Congress, and it will be held in Berlin. This is the decision of the international committee which was named at the last conference (in Paris) to select the place of the next meeting. Arrangements for the meeting are being made by a Berlin committee consisting of Dr. Thiel Exzellenz (president of the German Gardening Society) chairman; Dr. Boenisch and Dr. Kniebe as representatives of the German Minister of the Interior; Dr. Scroter and Dr. Oldenburg as representatives of the Minister of Agriculture; Prof. Dr. Krüss representing the Minister of Education; Kammerherr von Freier-Hoppenrade (President of the German Agricultural Society), Oekonomierat Hosch (president of the German Breeding Association), L. Kühle, (representing the Society for the Improvement of German Plant-breeding), Prof. Dr. von Rümker and Prof. Dr. E. Baur. The latter two are in charge of business arrangements. The address of the committee is: Berlin N. 4, Invalidenstrasse 42, Kgl. Landwirthsch. Hochschule.

THE SAPPHIRE HOG

A New Breed in Process of Formation—Origin a Mixture, Selection the Method of Procedure—Approximation to Type Already Secured, and Large Percentage of Pigs Breeding True.

J. A. McLean

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WE are rather loth to believe that there can be anything new under the sun. Especially is this true with live stock. Old things with valuable characteristics may be discovered in unfrequented corners of the earth and introduced, or new features not hitherto found in a particular breed may be embodied in its requirements. But live stock men, both breeders and teachers, have generally not advocated the creation of new types but have emphasized improvement of old stocks.

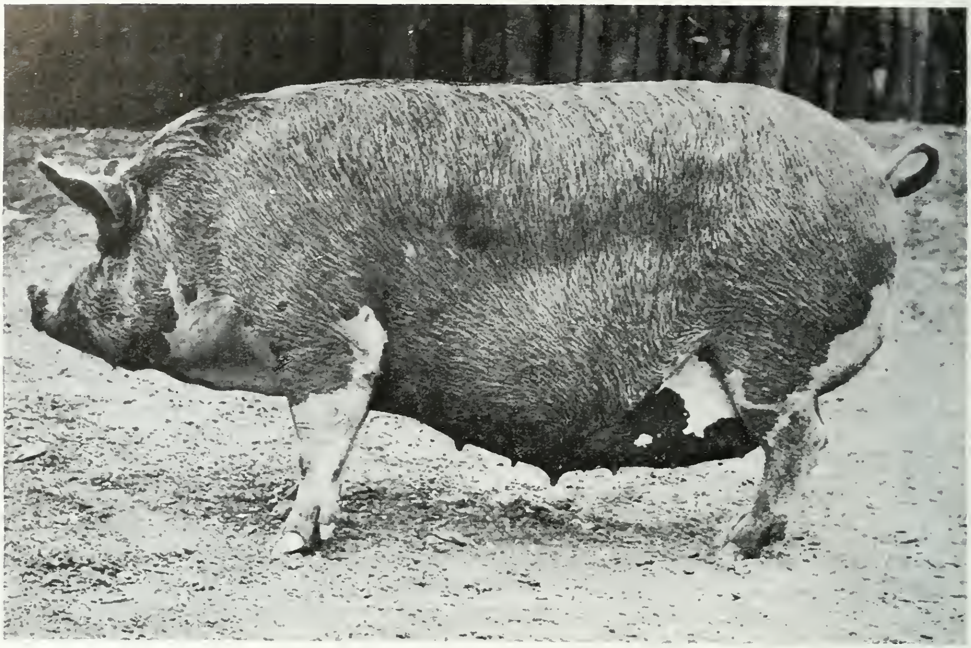
In plant breeding, hybridization has been one of the fruitful methods of producing new varieties, and plant breeders generally have not been slow to make use of this method of advancement. Is it not possible that animal breeders have worshipped pedigree too long and faithfully? Why might it not be possible, for instance, to combine the good qualities of the two breeds, Holsteins and Guernseys, and from them evolve a new breed distinctly superior to either? When we go back over the history of our breeds of horses, we find that each is of a more or less conglomerate origin; some of these breeds today permit to a certain extent, if they do not encourage, the introduction of outside blood. In most of our breeds of cattle the same conditions are found, as to origin. Crossbreeding, it is generally conceded, gives a greater vigor, a more rapid growth and consequently distinct market advantages. By careful selection, might not these features be retained in the succeeding generations from these hybrids? These are a few of the questions which demand a fair answer. Some experiment stations have undertaken to solve the many problems of this character, while a considerable number of breeders are also delving for the truth along these lines; and now one of the latter is coming to the surface with a so-called new breed of hogs.[1] Time will reveal the true merit of this breed. In the meantime, let us see what we can see.

THE ORIGIN OF A GENETIST.

About eight years ago, George C. Griffith, lawyer, Harvard graduate and younger scion of a Virginian family, was given but one more year's lease on life. He was enjoying his tenantry and, disliking very much to quit it so soon, he undertook to disappoint the prognostications of his medical servants. He bought a couple of New England stone piles with a very narrow valley and a stream between. He liked solitude, so he selected his hills three miles from town and well away from the main roads. Here he built a bungalow of most simple structure about the size of a box car, well up on the highest hill, from whose glass front he could see the mighty ocean. Here he began to win back life.

Since little of the land was arable, dairy cattle were scarcely feasible; poultry he disliked, and sheep were impracticable, so that swine production

[1]The breed was at first known as the Blue Hog. Mr. Griffith sent out an appeal far and wide for suggestions as to a permanent name, and that finally chosen was the idea of August Belmont of New York, himself a highly successful breeder as well as financier. The color, as livestock men will understand, is in fact a roan; the description of "blue-jay blue," which has been given in periodical literature, must be taken only as a figure of speech.



"VIRGINIA," A SAPPHIRE SOW

This animal, bred by the New England Live Stock Company of Peabody, Mass., weighed 408 pounds at 11 months. She is an excellent specimen of a new breed in the making. As Mr. McLean explains, this breed is made by selection from a mixture of Yorkshires, Hampshires, Berkshires, Essex and Chester Whites, and is now breeding fairly true, although the breeder finds it difficult to eliminate the white markings. (Fig. 8.)

became the only possible line of farm endeavor. A swill contract from a neighboring town gave a large supply of feed, so that this hog industry received a marked impetus. Within a couple of years, the man was well and found himself with a large hog business on his hands. He still retains his law office in Boston, but contrary to the usual practice, he finds time to visit that office only on Saturdays.

Almost from the very first Mr. Griffith had the distinct purpose of evolving a new breed of swine. In his first couple of years' work, with many hogs of all kinds, he saw many defects which helped to evolve the type of his new breed. Weak backs, pendulous bellies, broken down pasterns, heavy ears, were defects common and serious. The new breed should have none of these undesirable traits. Then, too, the color must be distinctive. Black, red, white—this had been the entire spectrum of hog shades. The new breed must have a new color, and Mr. Griffith chose blue from the very start; and without knowledge of the blue grays of the Shorthorn-Galloway cross. Lastly came the matter of head. The erect, trim ear of the Berkshire pleased, —but not the pug nose; long snouts were too often associated with narrow bodies, and narrowness between the eyes; while lopping ears obstructed the sight, which is surely not desirable. Thus has evolved briefly the conception of the type. The hogs of this breed shall be blue. They shall have trim bellies and be a trifle more upstanding than the average run of fat hogs; they shall have distinctly the fat hog form associated with excellent length of body; they shall have excellent strength of bone and be free from broken down pasterns; they shall mature earlier than any other breed of swine; they shall have erect, fine, rather small ears. The line from the poll to the end of the nose shall be medium short and the forehead

high; the top of the neck shall be slightly arched. They shall breed true to these characteristics. This, if you please, has been Mr. Griffith's conception of the breed before ever the Sapphire Hog was.

THE MEASURE OF SUCCESS.

To what extent has he succeeded? First let it be stated that the work is still in progress; none realizes better than the workman that his work is not complete. Yet he feels that much has been accomplished and that the end is in sight. There are now seven hundred Sapphire Hogs on his farm. He sells practically none of these, with certain exceptions. This gives him a large choice in selection of both sows and boars for breeding purposes. In these the color is variable, although the blue predominates. In a great many of these sapphires there is a white belt of variable width just back of the shoulder similar to that in the Hampshire. This white belt is accompanied by white on the belly, white nose and face, and white feet. Many lack the white belt but have the other white markings, while still others have blue body, legs and feet, but are lighter colored about the snout. The blue color seems to advance by degrees and the hardest white marking to eliminate is that of the snout, and next, that of the feet, and next to that the "Hampshire belt" and white belly. But there were a large number of "all blue" pigs, though generally with them the face was a trifle lighter in shade and in the forehead invariably there was a slightly darker spot. The shades of blue vary from quite light to almost black. This is due to the proportion of white to black hairs, for the blue color is due to the free intermixture over all parts of the body of black and white hairs. There is no shading of the individual hairs. The skin is pigmented wherever the roaning occurs, but is not as fully pigmented as is that of a pure black hog.

Several peculiar patterns occur in the uniformly blue pigs. There are some pigs which have a mackerel pattern in the blue, due to areas containing a larger proportion of black hairs. These present very much the same marbled appearance that is seen in some gray-colored cats. There are quite a few pigs that have distinct dark stripes about half an inch wide running lengthwise of the body, and from one to two inches apart. In some these stripes persist through life.

SOURCE OF THE NEW BREED.

The source from which this new breed is being evolved is conglomerate. Yorkshires medium and large, Hampshires, Berkshires, Essex, and Chester Whites have been freely used; Tamworth and Poland Chinas have not been used, though it is probable that some Duroc Jersey blood was mingled in the earliest crossing; but the pure black, the pure white, or the black and white breeds have been distinctly the basic stock. Pigs of good individuality have always been selected and while money has never been thrown away in high prices, yet it has never been withheld when a desirable hog for breeding purposes was found.

The first departure towards the blue color occurred about five years ago. This was a white sow with a very slight tendency to roaning upon her sides. Necessarily in the selection for color at first, some leniency in regard to other characters had to be exercised, but now only uniformly colored boars are used that have a good percentage of the other characters demanded. In the boars, the type of head, the strength of bone, the color and the conformation are all insisted upon. In the mature sows more variation still exists. One sees the old fashioned Berkshire snout and lop ear, and the white belt and other white markings quite generally.

There are a good many litters upon the place that are all blue, though they vary in the shading. A sapphire boar from sapphire dam and sire was mated to twenty-seven sows of other breeding carrying no sapphire tendency. Thirty per cent. of the offspring were sapphire and the highest per cent. in any one litter was 40.

It is to be expected that vigor and early maturity will appear in these

hybrids. Mr. Griffith has obtained sows weighing 600 pounds at 16 months, and thinks his hogs mature about two months earlier than any of the pure bred breeds which he carries on an equally large farm not far away.

"When we get through with them, they shall be uniform and breed true," was one of Mr. Griffith's last remarks to me, and one felt that if it can be accomplished at all, it will be. It might seem that perhaps these sapphire hogs can not be more "true blue" than can the Blue Andalusian fowls. We know that in certain fancy breeds of rabbits there are many wasters in every generation. Judging from a day's visit at the farm, this would not seem to be the case with the hogs, for from sapphire sows bred to sapphire boars, there were very few litters that carried pure whites or pure blacks. There were, however, litters from spotted sows that had only one cross of sapphire in the ancestry, that had in their litters pure blacks, spotted ones like the dam, and mackerel-marked sapphires.

There were other exceedingly interesting variations in color which, if they will breed true, will some day also appear as breeds; from a hereditary standpoint, they are now exceedingly interesting. There was, for instance, a Titian coated young sow of unusual beauty and a shade of color I have never seen in Tamworth or Duroc Jersey. There were a half dozen very uniformly and peculiarly marked black and white pigs, which promise interesting results.

No claim for immunity is made for the breed, but it is an interesting statement of fact that although these pigs, by the thousand for the last five years, have been raised almost entirely on city swill, yet there has never been any outbreak of cholera.

Such is the Sapphire Hog in the making.

NEW PUBLICATIONS

HANDBUCH DER LANDWIRTSCHAFTLICHEN PFLANZENZÜCHTING, Band I, Allgemeine Züchtungslehre (Handbook of Agricultural Plant-Breeding, Vol. I, General Principles of Breeding) by C. Fruwirth. Pp. xxiii+442, price M. 14. Berlin, Paul Parey, 1914.

The first volume of Professor Fruwirth's encyclopedic work on plant breeding has been rewritten and issued in its fourth edition. As a compendium of knowledge on every aspect of plant breeding, it stands unrivaled; it must be admitted that nothing equaling it has been produced in the English language. It is difficult to think of any subject connected with plant breeding which the author has not discussed fully and profoundly. Pains have been taken to keep the practical work of the breeder in mind, but from its nature, the volume is highly technical, and will be of value only to professional students of genetics. To the great body of them who are teaching genetics in colleges or practising it at experiment stations, the book would seem to be almost a necessary part of their equipment.

Vol. III, A. B. A. Reports, Wanted

A member of the American Genetic Association wants a copy of Vol. III, annual reports of the American Breeders' Association, to complete his file, and has expressed a willingness to pay $5 for it. Any member willing to dispose of his copy at this price is requested to notify the secretary. Copies of Vols. I, II and V are also in demand, and the secretary will be glad to learn of the whereabouts of any of these volumes which the owners are willing to relinquish.

BIOLOGICAL EUGENICS

Relation of Philanthropy and Medicine to Race Betterment—Study of Genetics Shows that no Race Can be Bred Immune to All Diseases or Defects—Nevertheless, Medicine and Charity Must Pay More Attention to Heredity[1]

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IN ACCEPTING the invitation to speak before this Conference on the subject of The Relation of Philanthropy and Medicine to Race Betterment, I wish to make it clear that I do so with no special knowledge of medicine or of sociology. But if by Race Betterment is meant in this instance the production of an inherently better race rather than simply the bettering of conditions—if it means biological improvement rather than social improvement—then I may perhaps avoid the charge of presumption, since neither medical science nor sociology has as yet amassed sufficient data for a very clear understanding of what their biological effects upon the race may be. Consequently the subject may be regarded to a considerable extent in the light of biological analogy, and if such facts as are known fit in with biological theory and deductions in other lines, we may from this gather some assurance that we may apply the reasoning of biology, in its narrower sense, to the destiny of mankind, which is, of course, a cognate field of biology in its broader meaning.

For we must not forget that man is still an animal, however much he may specialize socially; and although he may by his superior knowledge abrogate many of the laws which bind his more lowly kin, the bird, the fish, the maggot, or ameba, he cannot hope to escape from the operation of certain of nature's methods, and one of the most fundamental and tyrannical of these is that of reproduction. The heritage of society is passed in an uninterrupted flow from one generation to the next; but not so the biological inheritance, for between the individual of one generation and that of the next there is a rearrangement, a shuffling of the cards face down, leading to an indefiniteness of results which has long made this problem one of the most difficult of biological questions.

So it is as a biologist that I propose to discuss the question before us, and I believe you will agree that until we have enough facts to enable us to see definitely what medicine and philanthropy are actually doing for the race, we shall have to predict as best we can what they will probably do from our knowledge of general biological laws; and our predictions will have value directly in relation to the correctness and extent of our knowledge of these laws. This becomes at once apparent when we consider the diametrically opposed attitudes of certain biologists, sociologists and social reformers. One believes that the human race already possesses the potential factors for a richer and fuller life, that this more or less latent potentiality is rather universally distributed, at least within certain group limits,[2] and all that is needed is a better environment to bring it out. Such maintain that biological evolution has largely stopped in the case of civilized man, and that social evolution,

[1]Address (here abridged) delivered before First National Conference for Race Betterment, Battle Creek, Mich., January 8, 1914.

[2]See for example Smith, S. G., "Social Pathology," New York, 1911, section on Eugenics, especially pp. 308 and 309.

the evolution of the environment, has completely taken its place. Thus Smith in his Social Pathology, asserts that while "Charles Darwin may learn important lessons from pigeons and pigs, and a brood of lesser men may talk about human marriage in the terms of the stock farm, . . . the men of our generation who are studying the problems at closer range will more and more discuss them in terms of social psychology."[3] Another holds that evolution and selection, or evolution by selection, is in effect as always; that the potentialities of individuals differ, and that they develop differentially according to this inherited potentiality and to the limiting influence of the environment. Furthermore, that such individuals as are able to survive the environment and to produce offspring, bequeath to their successors only that which they themselves inherently possessed. Or still others, while believing that Natural Selection is biologically operative, attribute to the environment an ameliorating effect upon the germ plasm, which means the "inheritance of acquired characters." When men differ to this extent in their interpretation of natural laws, is it surprising that they fail to agree on specific means for race betterment?

PHILANTHROPY AND MEDICINE.

At first thought it might seem odd that philanthropy and medicine should be classed together in a discussion of this nature. The former draws upon the resources of the individual, or of the state, if we use the somewhat broader word charities, while the latter is ordinarily a source of income and livelihood to the individual practicing it. In this sense the same might be said of agriculture or manufacture. But medicine and philanthropy have this in common—the one tends to relieve the want, the other the suffering, and both often to prolong the life of the recipient.[4] And for this last reason they are both of the same immediate eugenic importance. I shall therefore treat of them together in general, discussing specific instances from one or the other as the case may be.

Almsgiving and charity are as old as history, and it is generally conceded that these give advantage to the biologically and sociologically unfit which enable them to live longer and to propagate more than they normally would. But with one or two exceptions, until recently, no thought was given, so far as we know, to the possible influence of this upon the race. Nevertheless, to quote Warner,[5] "Plato, more than two thousand years ago, warned his countrymen of the degradation in store for any nation which perpetuated the unfit by allowing its citizens to breed from enervated stock; and he sketched for them an imaginary republic in which no considerations of inheritance, of family ties, or of pity were permitted to stand in the way of the elimination of the weak and the perfection of the race."

With the rise of the study of economics these questions often came to the fore, and then the whole matter was given a new turn by the revolutionary ideas of Natural Selection which permeated so many fields after Darwin's publication of the "Origin of Species." Biologists and others were not slow to apply the new ideas to man's racial development, and from this time really dates the period of active discussion, and often violent disagreement, on the relation of social advance to race improvement or degradation.

As social reformers were concerned with bettering the environment, a work which could often be seen to produce immediate and marked results in adding to the health and material comfort of the populace as a whole, the gradual almost complete acceptance by biologists of Weismann's doctrines as to the non-inheritability of environmentally produced modifications naturally led to a widening of the breach between those who placed their faith in social measures and those who foresaw the direful effects

[3] *Loc. cit.*, p. 304.

[4] "The most obvious result of charity as a selective force has been to lengthen the lives of the individuals cared for."—Warner, A. G., "American Charities," New York, 1908, p. 23.

[5] "American Charities," 1908, p. 20. See also, Pearson, K. "The Scope and Importance to the State of the Science of National Eugenics," Eugenics Lab. Lect. Series, I., 1909. pp. 23, 24.

of what they believed to be the increasingly disproportionate ratio of defective racial germ plasm. The social reformer was accused of being shortsighted, like a mariner driving his ship ahead because the wind is fair and the weather looks pleasant, but utterly regardless of hidden shoals. Or he might be likened to the unscientific farmer who, because a particular crop is profitable, grows it year after year in the same ground without rotation until the land is depleted or "sick" and will no longer produce. Or again, like the capitalist who razes the forests or despoils the earth of minerals with all thought to his present gain, and none for future generations.

On the other hand those who called attention to the biological consequences of the withdrawal of selection were called "dismal scientists" and alarmists; it was maintained that "the mutilation or destruction of the unfit would make society as a whole increasingly cruel. It would produce a despotism of pseudo-science that would be more crushing to all the gentler virtues of men than any political despotism ever known."[6]

WARNER'S ATTITUDE

Between the views outlined above we find that intermediate positions have been taken by a large group both of social workers and of biologists. A few examples may serve to illustrate. Warner, who during his short life was one of the foremost social workers in America, far-sighted and discriminating, though primarily interested in practical charities, clearly recognized the importance of heredity in racial progress. He nevertheless emphasizes the value to the race of altruistic sentiments, though he recognizes the necessity of prevention of multiplication of the unfit. Thus he says:[7] "Could we cheaply rid ourselves of incapables and close our hearts to the appeals of distress, we might never have the compulsion put upon us of seeking out the wiser plans, which may eventually give us a more uniformly healthy race. Extermination might be an easy cure for pauperism, but it would be a costly remedy biologically; and if we allow our instincts to compel us to forego the use of it, we may ultimately be driven to preventive measures." He is doubtful, however, as to the efficacy of sterilization, and is inclined to the view which is now gaining wide acceptance that the most efficacious remedy is going to be segregation. He points out that in many of our almshouses there are sometimes inadequate means of separating the sexes, and "the breeding of paupers goes on upon the premises," and even that "formal marriages between almshouse paupers have very frequently received the sanction of both church and state." He concludes his chapter with the following very sane statement:[8] "Certain it is that while charity may not cease to shield the children of misfortune, it must, to an ever increasing extent, reckon with the laws of heredity, and do what it can to check the spreading curse of race deterioration. The desire to prevent suffering must extend to the desire to prevent the suffering of unborn generations."

Among those who have in their treatment of this subject emphasized the importance of the Natural Selection viewpoint may be mentioned especially Herbert Spencer, Francis Galton and Karl Pearson, the director of the Galton Laboratory for National Eugenics, though many other names might be mentioned as well. The last named has turned the energies of his laboratory to studying by means of highly developed statistical methods the inheritance of various diatheses, traits and defects, as well as the effects of ameliorative measures. In his Cavendish Lecture for 1912, entitled "Darwinism, Medical Progress and Eugenics,"[9] we find his position well set forth. After marshalling the data of his laboratory to prove that "general health is inherited and that the infantile death-rate is selective," he sums

[6]Smith, "Social Pathology," 1911, p. 294.
[7]*Loc. cit.*, p. 25.
[8]*Loc. cit.*, p. 31.
[9]Eugenics Lab. Lect. Series, IX, 1912.

up so well that I cannot refrain from quoting. He says: " . . . these are individual illustrations of what is happening, because the intensive selection of the old days has been suspended. That suspension is partly due to medical progress; you are enabling the deformed to live, the blind to see, the weakling to survive—and it is partly due to the social provision made for these weaklings—the feeble-minded woman goes to the workhouse as a matter of course for her fourth or fifth illegitimate child, while the insane man, overcome by the strain of modern life, is fed up and restored for a time to his family and paternity. In our institutions we provide for the deaf-mute, the blind, the cripple, and render it relatively easy for the degenerate to mate and leave their like. In the old days, without these medical benefits and without these social provisions the hand of Nature fell heavily on the unfit. Such were numbered, as they are largely numbered now, among the unemployables; but there were no doctors to enable them to limp through life; no charities to take their offspring or provide for their own necessities. A petty theft meant the gallows, unemployment meant starvation, feeble-mindedness meant persecution and social expulsion; insanity meant confinement with no attempt at treatment. To the honour of the medical profession, to the credit of our social instincts, be it said, we have largely stopped all this. We have held out a helping hand to the weak, but at the same time we have to a large extent suspended the automatic action whereby a race progressed mentally and physically.

MEDICAL PROGRESS VS. EUGENICS.

"Surely here is an antinomy—a fundamental opposition between medical progress and the science of national eugenics, or race efficiency. Gentlemen, I venture to think it is an antinomy, and will remain one until the nation at large recognizes as a fundamental doctrine the principle that everyone, being born, has the right to live, but the right to live does not in itself convey the right to everyone to reproduce their kind.

"Our social instincts, our common humanity enforce upon us the conception that each person born has the right to live, yet this right essentially connotes a suspension of the full intensity of natural selection. Darwinism and medical progress are opposed forces, and we shall gain nothing by screening that fact, or, in opposition to ample evidence, asserting that Darwinism has no application to civilized man."

I have made these quotations frankly and at length because I believe they will show you, more faithfully than I could perhaps have done it in my own words, the positions held by various students of race progress and betterment. I believe that any reasonable person must agree with Pearson that in spite of the masking influence of the increasingly complex social heritage which is passed on from generation to generation in our customs, beliefs, books, laws—in fact in all our increasing knowledge of science and the arts—nevertheless biological inheritance is operating in man now on the same principles that it did when he swung the stone axe, or scuttled through the trees with his simian congeners. The detailed studies of individual lines of inheritance which have in recent years been made from the Mendelian viewpoint[10] leave no doubt of this. Furthermore, this being true, it must be conceded by all thinking persons at all conversant with biological principles that selection plays the same role in directing the course of heredity, that is the surviving line of germ plasm, that it always has. Note that I say *selection* here rather than *Natural Selection*, for the latter term is associated in many minds with the crude methods of Nature uninfluenced by sentient forces. Will anyone deny that the animal or plant breeder utilizes the same principles of selection in breeding his cattle or his corn that have in Nature brought about the evolution of one form from another? The difference is that instead of being *Natural* selection it is now *conscious*

[10]For a summary treatment of these see Davenport, C. B., "Heredity in Relation to Eugenics," New York, 1911.

selection on the part of the breeder, and he directs the processes of change, in so far as his art enables him, along the lines which his needs or his fancy direct.

Now as man's mental capacities began to develop the course of selection shifted increasingly on to these, and they became more and more important as his social relations and capacities grew. I am not prepared to assert that the minds of the highly civilized ancient peoples, such as the Greeks, the Egyptians, or even more remote cultures might not be capable of assimilating and utilizing to the full the complexities of our present social and political conditions, our inventions and our scientific knowledge—indeed recent Japanese history would be argument in favor of such a view; but certainly this cannot be said of the more primitive races, and therefore some mental evolution must be postulated from such a condition To my mind the course of evolution presents a picture somewhat like that of a small stream of water making its way down an almost level but slightly irregular surface. Tongues are sent out this way and that as slight depressions lead here and there, and at times a considerable course may be made more or less consistently; but then a higher obstruction is reached and a new course started, determined by the point of lowest level. No matter how well one branch has progressed, if another finds a lower spot it diverts the stream. Just so races and civilizations have arisen and prospered and flourished until others superior in brute strength, in organization, or in equipment in arms, have come in and superseded them.

DEFECTIVES GROW IN NUMBER.

Until social customs became comparatively highly developed individual physical prowess was as necessary to existence as among the lower animals. This was in the stage of individualism. With specialization, as particular classes in a community took up certain special tasks, and especially as armies were formed not including the total population, physical selection became relaxed for some of the individuals. These conditions have become more pronounced until modern philanthropy and medical science are bringing them to a point where they can no longer be ignored. Neither the greater diligence in seeking them out nor the fact that they remain in institutions for longer periods will account for the disproportionately increasing number of defectives and criminals in our population. This fact seems demonstrated and one does not merit the epithet of alarmist for pointing it out. And if true, must we not give thought to its remedy?

Just as, when the human race developed from the savage, artful means of preservation superseded purely physical, and as the breeder has replaced fortuitous natural selection by conscious selection, so I believe the time is at hand when mankind will find it necessary to substitute some form of *rational* selection for the hit-or-miss, happy-go-lucky way they have drifted along in the past. Exactly what this method shall be I do not think we are in a position at the present time to say. Two chief lines seem open, restrictive and constructive—sometimes called negative and positive eugenics. The quotations which have been made in the earlier part of this discourse show clearly, it seems to me, that the former measures may be adopted under certain conditions without doing violence to the finer instincts of the race, without in any way destroying or lessening altruism or humanitarianism. In our nationwide agitation for conservation we are just beginning to realize our duty to future generations. The case is a close parallel, for we are saying that the material benefits of our forests, our minerals and our water power must be conserved for the benefit of all the people, and not reaped now to enrich a few individuals and to be passed on only to their families. Shall we have less foresight in the heritage of defectives and cripples that we pass on to the next and future generations? Is not the social reformer who does not take this into consideration spending all his thought on bettering the present generation, just as exhausting our national resources might enrich this generation but pauperize the next?

Now, if it is going to be necessary for us to practice some degree of rational selection, we must be sure that it is rational—it must be based upon positive knowledge. What has modern biological research to offer in the way of contribution to such knowledge? In the first place we can readily see that a large part of the disagreement which has been mentioned is due to difference in opinion as to the influence which the environment may have on the individual and on the offspring. It is the old question of Nature and Nurture. While I am free to admit that in its abstruse aspects this is one of the most difficult questions confronting the biologist, I believe that much unnecessary confusion and needless discussion has resulted from the tendency of writers to exaggerate their views either on the one side or the other, and not to accord the question fair treatment. When I am asked, as often happens, which I consider of greater importance, heredity or environment, I commonly give a Yankee reply by asking in return, Which is of more importance for sustaining life, food or air?

INFLUENCE OF ENVIRONMENT.

Although we may concede what is the almost universal biological opinion of today, that the effects of environment are not in the crude sense heritable, we must not, nevertheless, lose sight of the fact that the environment is a most inportant determining factor in evolution and in selection. This may perhaps best be illustrated by an example. Let us suppose two cows, one of which is inherently a low producer, and is incapable of producing any considerable quantity of milk beyond that necessary to raise her calf. The other, on the other hand, has inherited the capacity to produce a large quantity of milk under certain conditions, namely proper feeding, care and handling. Now let us first consider these animals under, say, range conditions, where they receive no special care, and where they have to hustle for their own maintenance. So far as milk production is concerned they will measure up about the same—each will produce enough to raise her calf and no more—and very likely the inherently low-producer will be at an advantage under these more severe conditions. But now take the two animals and place them in a modern dairy with scientifically prepared rations, and the best treatment that modern dairy practice can provide. What is the result? The animal which inherited the capacity to respond to such treatment does respond at once by a sustained increase in the flow of milk; but the other does not. The former was hampered by conditions in the first place, but the latter is now absolutely prevented by her nature from the possibility of a response to the improved conditions. We see therefore that these conditions were necessary to make apparent the differences which existed in the hereditary make-up of the two animals. Is not the same true of the human race? It is only by giving opportunity to all, that we may know which are capable of profiting by that opportunity. The good environment then is necessary for differentiation, and without differentiation how may we hope to make selection?

Two other biological concepts are of importance. These have grown out of recent Mendelian investigations. The first is the idea of hypothetical factors, which are definite heritable units, and upon the presence of one or more of which all the characters of an organism depend. Since the factors behave for the most part independently in inheritance, the problem of handling them in selection becomes an extremely complex one. Where only two factors are concerned, any desired combination as to their presence or absence may be expected in at least one of sixteen individuals in the second generation. But as the number of factors to be dealt with increases, the number of individuals necessary to give all the combinations increases at a most disproportionate rate, as is indicated in the following table, which shows the number of individuals which according to expectation would be necessary to produce at least one individual with each

of the possible combinations under the conditions most favorable for bringing them about:

1 factor,	4	individuals.
2 factors,	16	"
3 "	64	"
4 "	256	"
10 "	1,048,576	"

Certain conditions, such for example as certain striking defects or abnormalities, may depend upon the presence or absence of a single factor, and it might be comparatively simple to deal with such cases singly. But the difficulty of dealing with any considerable number, especially in the case of man where conditions are very different from those of animal or plant experimentation, may be readily appreciated. It might be possible by prohibiting by law certain marriages and encouraging others to breed a race of mankind free from the diathesis toward a particular disease, let us say; but think of the number of diseases alone with which man has to contend and consider again the above table. And then tell me how soon eugenics is going to produce an "ideal race," made to order, as the newspapers would have us believe is its aim.

Such speculations may do for the visionary who likes to speculate what the world may be like a century or twenty centuries hence; but the practical eugenist is merely trying to determine how what knowledge we have gained to the present may be turned to the best advantage for race improvement as distinguished from individual amelioration. At the present time it would seem that we are in a position to apply certain phases of restrictive eugenics with comparative certainty of results, such for example as the cutting off of those definitely defective lines of germinal protoplasm which are beyond hope of hereditary improvement.

POSSIBILITY OF SEGREGATION.

As to the methods which shall be employed, it is coming, I think, to be generally conceded that permanent segregation, at least during the period of reproductive capacity, is going to prove the most feasible if not the most effective of restrictive eugenic measures. But we must be certain of whom it is necessary to segregate. The recent advance of knowledge in this line has been considerable, but it is only a beginning, and I must say that it is due more to the work of biologists than of physicians. Experimental breeding of plants and animals has supplied the keys which have unlocked some of the puzzles of human inheritance, but what we need now are more facts, the facts which can be gathered from the hospitals and asylums, from vital statistics and from the case records of practitioners. But these facts must be gathered with a fullness and accuracy, and with a view to the purpose they are to serve, which has not been customary in the past. It is a deplorable fact that comparatively few medical men have very clear ideas of heredity, or indeed evince much interest in the subject, and few realize its importance.

I have not had time in this discourse to touch upon specific diseases, operations and charitable procedures, and to discuss their relation to the question in hand as I should like to have done. It has no doubt occurred to many of you to ask, however, suppose we grant the necessity of restricting the reproduction of the obviously unfit, what about operations in other cases, the treatment of endemic and epidemic diseases, and the like? Is removing the appendix or the tonsils or the turbinal bones going to be to the race like the drug habit to the individual—once begun, having to be continued in ever-increasing doses? It may be. It is possible that the popular idea of the predicted "hairless, toothless race" may not be so far from the mark, or at least that this type shall increase in numbers unless sentiment against it becomes so strong as to become a selective factor. I wish merely to point out that the filling and crowning of our teeth is not going to insure better teeth for the next generation any more than wearing a set of false ones would; if selection is eliminated, the individuals of the next generation will have to take their chance of inheriting a better or a worse dental battery than their parents. My point is simply, that if the inheritance of the factors concerned were

understood, by selection of the parents good teeth could undoubtedly be insured to the next generation. But the question would have to be asked, would it be worth while? The breeder knows how hard it is to fix a number of characters at one time, and the student of genetics understands why; and while effort was being concentrated on the teeth other characters would run riot. The difficulties are further magnified by the fact, greatly emphasized in recent studies, that the way in which a character will be inherited often cannot be determined by its appearance in the individual. This is a fact which has been almost completely overlooked or ignored in the discussions of sociologists. So the conservatively inclined need not be alarmed that practical eugenics will do much more than to eliminate the more obviously unfit for some time to come.

If time permitted I should like to discuss the question of whether, in the case of certain specific diseases, such for example as tuberculosis, the greater promise for the race lay in selective heredity, or in environmental adjustments, such as prophylactic measures, antitoxins, treatment and the like. My feeling is that in most of these specific cases the race will find it most expedient to do as now, except in such diseases as denote general physical or mental defect or weakness. Take the case of cancer for example. Suppose it were found to be definitely inherited, but that medical science could find an easy and early diagnosis and certain cure. Would it not be simpler and easier to cure it as it appeared, even though its incidence should be even larger than now, than to cut off all affected lines of germ plasm? For certainly the stock that would be eliminated by such measures would be an inestimable loss to the world.

The very specificity of disease coupled with the difficulty of selecting for a large number of characters at once, and taken in connection with man's present cosmopolitanism, by which all diseases are becoming distributed all over the world within their possible ranges—all these factors make the breeding of a race of mankind immune to all, or even to a large number of diseases, a practical impossibility.

Eugenic selection must, I believe, for a long time be confined as I have said to cases of marked defect and weakness. In addition more study must be given to those influences which may weaken the germ plasm directly, such as alcohol. And medical science, rather than desisting, must push on, especially in the field of general prophylaxis, but with more thought to succeeding generations and the future of the race than it has given in the past. Philanthropy and charities cannot stop, but they must take more counsel of established sciences, and like medicine, give more thought to the future.

Left-Handedness

As left-handedness is an inherited character, apparently behaving as a Mendelian recessive, it is interesting to note the belief of some investigators that it is one of the stigmata of degeneracy. Bardeleben is quoted in German periodicals as saying:

"That a few great men, such as Leonardo da Vinci, were left-handed, does not neutralize the prevalent belief—in all ages—that left-handedness implies a sub-standard subject. The percentage of left-handed recruits is but 6.8; of school children somewhat higher. These figures are very deceptive, however, for of the left-handed children who became right-handed, the percentage is some 26. This, added to the persistently left-handed, raises the original percentage of left-handed considerably."

After pointing out that the gibbon and orangoutang are as a rule right-handed, and the gorilla and chimpanzee left-handed, the speaker decided there was no evidence at all that a left-handed person was mentally or physically inferior.

THE ORIGIN OF DOMESTIC FOWL

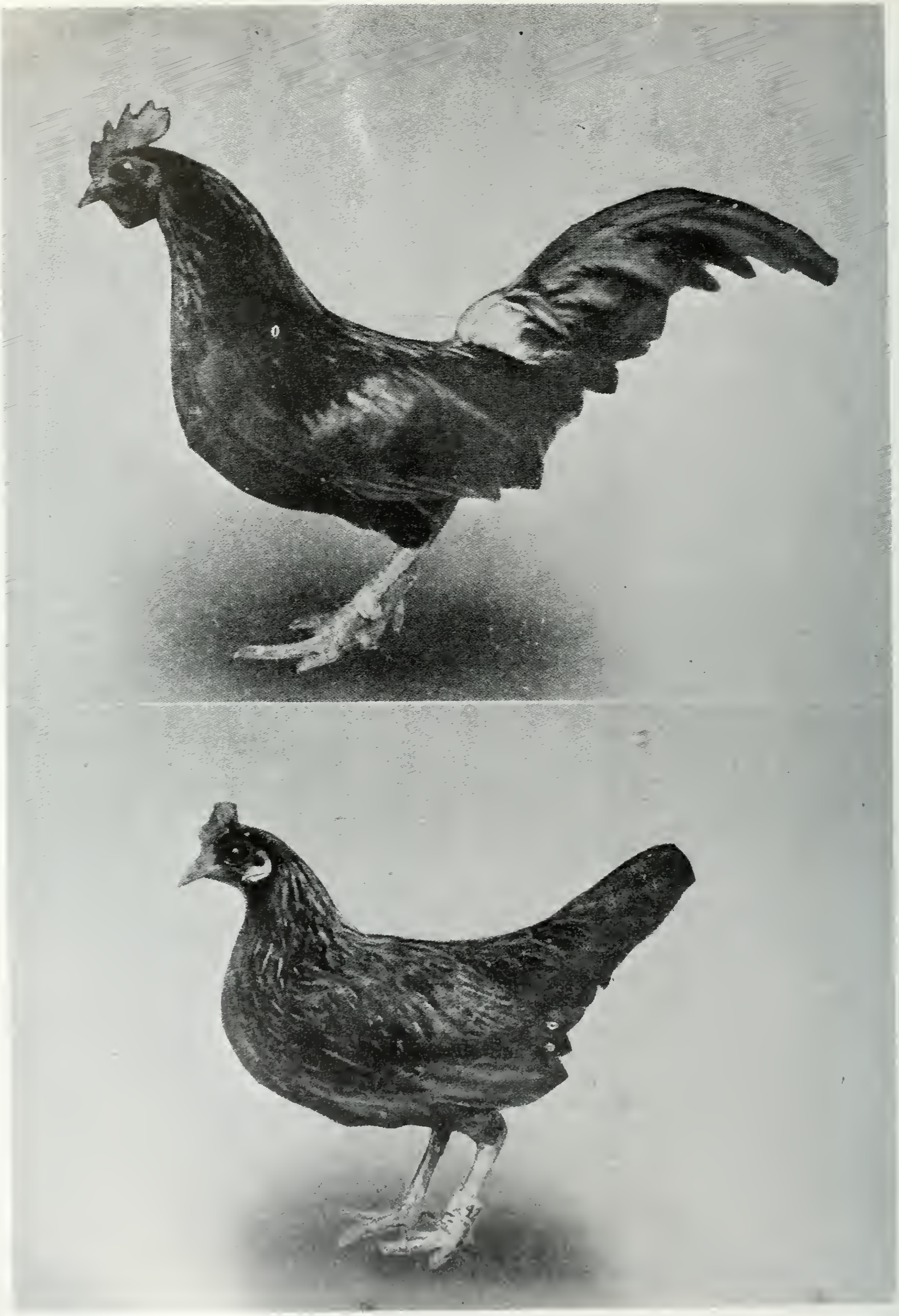
C. B. Davenport
Cold Spring Harbor, Long Island, N. Y.

It is commonly stated that the Jungle Fowl (*Gallus ferrugineus*) of India, southern China and the East Indies is the ancestor of our domestic fowl. But when we consider the great variety of characters that our domestic races exhibit it becomes hard for us to understand how they could have arisen from a single source. It is, indeed, pretty certain that two distinct species have contributed to the formation of our well known races:—one is the Jungle Fowl, which is still found wild, and the other is the unknown ancestor of the Aseel or Malay Fowl, probably the oldest fowl in domestication, for it has been bred for over 3000 years. It is still possible that the ancestor of this bird or its bones may be found in the interior of New Guinea, Borneo, or the Philippines.

The Aseel has many points of difference from the Jungle Fowl and brings in a whole set of characters that our domestic races have and the Jungle Fowl lacks. Thus the Jungle Fowl is a slender, agile bird with long wings, erect tail and a good flyer; while the Aseel is a very broad, heavy bird with short wings, drooping tail and unable to fly. The Jungle Fowl has a long, slender beak; that of the Aseel is short and thick. The comb of the former is single, high; that of the latter, triple (or "pea") and low. The former has slender, olive colored shanks; the latter thick and yellow shanks. The Jungle Fowl has a red eye; that of the Aseel is pearl colored. The Jungle Fowl has the well known English Black-breasted Red Game pattern; the Aseel is mottled. The Jungle Fowl is the foundation stock of our nervous, flighty, egg laying races—the Leghorn, Minorca, Spanish, Andalusian, etc.—the races that first spread over Europe, probably from the stock that was brought back from Persia by the expeditions of Alexander the Great. All of these races ordinarily carry the determiner of the Jungle type of coloration. Representatives of the Aseel type (which had long been established in Eastern India and China) were brought to America, becoming the ancestors of the Asiatic breeds and the fine, general-purpose breeds—the Plymouth Rocks, Wyandottes, Orpingtons, etc. Such do not regularly carry the Jungle type of color pattern. In one case, on the contrary,—namely in the Buff Cochins,—they introduced a new kind of color which (arisen in China 1500 years ago) has never been produced independently since. The fowl of the Aseel type are poor egg layers but their stocky build and great size make them unrivalled as table birds.

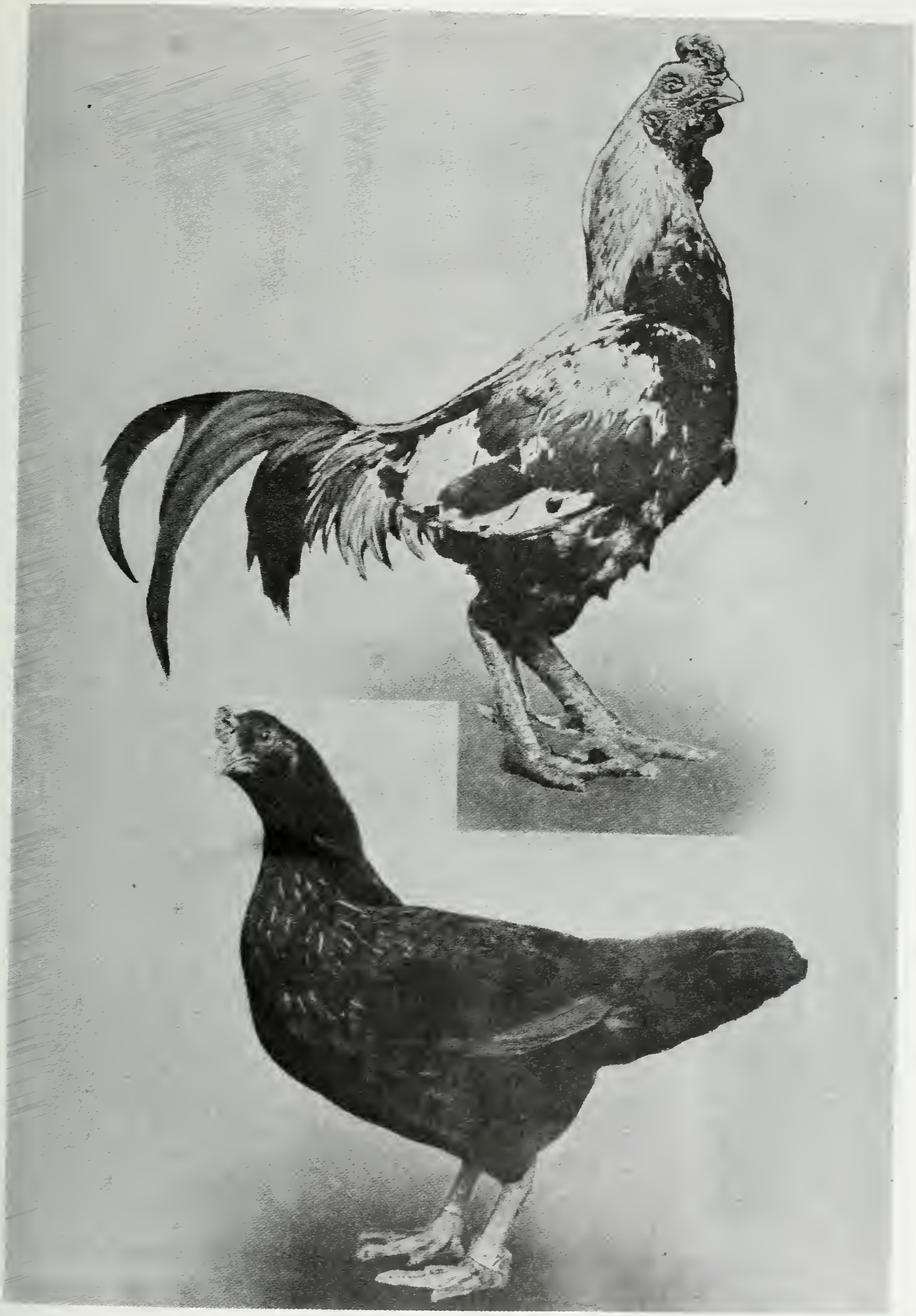
Racial Origin of Successful Americans

Dr. Frederick Adams Woods, chairman of the research committee in eugenics of this Association, writes in the Popular Science Monthly (April, 1914) on "The Racial Origin of Successful Americans." His study is confined to men of distinction or high official position in the four largest cities of the United States. He finds that those of English and Scotch ancestry are distinctly in possession of the leading places, at least from the standpoint of being widely known; and, in proportion to their number, the Anglo-Saxons are from three to ten times as likely as are the other races to achieve national distinction in the United States at present.



THE INDO-MALAYAN JUNGLE FOWL

Male above, female below. Note the slender form, the high, single comb, the long beak, the erect tail, the long wings and the nervous attitude, in comparison with the corresponding characteristicts of the Aseel. Between them, these two breeds supply all the characters shown in the many modern breeds of poultry, in Dr. Davenport's opinion; but the Jungle Fowl alone, which was formerly considered to be the ancestor of all modern breeds, is not able to account for them all. (Fig. 9.)



THE ASEEL OR MALAY FOWL

Above, a male. Note the stocky build and broad chest, the pea comb and overhanging brows, the short, heavy beak, the absence of marked wattles, the place of which is taken by a median "dewlap"; the short wings, drooping tail, stocky feet and short toes. The plumage is mottled and the hackle and saddle feathers are without red lacing. Below, a female: note the shafting (as in the Jungle Fowl), but the absence of mossiness on the wing feathers. (Fig. 10.)

RESULTS OF EARLY MARRIAGE

Does It Lead to the Production of Desirable Children, or of Mediocrities?—Need for Facts to Substantiate Theories—Reward Offered for Production of Cases Where Rapid Breeding Led to Good Results from Intellectual Point of View.

CASPER L. REDFIELD, *Chicago, Ill.*

MUCH has been said in advocacy of earlier marriages of our superior men and women for the purpose of improving the race by producing more numerous progeny from that class of people. A recent example is the article by Professor Roswell H. Johnson in the Journal of Heredity (Vol. 5, p. 102).

He says that "we *must* have our superior men marrying earlier, even at the cost of their early efficiency." Also, that we should "cease prolonging the educational period past the early twenties," and that our present practice of delaying marriages by extending education into post-graduate studies "cannot go on without serious loss to the race." To illustrate his point Professor Johnson furnishes a diagram showing the great increase in population coming from reproducing at the rate of four generations per century as against reproducing at the rate of three generations in the same time. He says:

> "Suppose a generation to be 25 years or 33 1-3 years respectively in two different stocks, and that all persons marry and each couple have four surviving children, or two for each parent. The result is that the 25-year stock constitutes two-thirds of the population at the end of a century."

The object of reproducing at the rate of four generations to the century is, of course, to produce superior individuals and increase the relative number of them in the entire population. Well, I will donate one hundred dollars to the treasury of the American Genetic Association if it can be shown that any superior individual ever was produced by breeding human beings as rapidly as four generations in a century. It is only necessary to find some superior individual from the intellectual standpoint whose date of birth is not more than one hundred years after the average date of birth of his sixteen great-great-grandparents. Any one of the 2,000 or 3,000 intellectually eminent men known to history, who comes in the four-generations-to-the-century class, will draw the hundred dollars.

To make the matter interesting and easy, I will be satisfied to give the one hundred dollars if there can be found more than three cases in which the intellectually superior person has as many as four generations in a century in the tail-male line alone. The three cases are an allowance of about one-tenth of one per cent. for errors in records or possible cases in which the putative father is not the real father.

In the northern part of the United States, and in the central and western part of Europe, the average time for three generations in the tail-male line is approximately 97 years. It is much less in most other parts of the world. In three generations of ancestors there are one father, two grandfathers and four great-grandfathers—a total of seven males. In any case in which the average age of these males was 33 1-3 years or less at the time the succeeding persons in the pedigree were born, the final product would be in the three-generations-to-the-century class—males only considered. It will be evident that much more than one-half of all people come within the three-generations-to-the-century class as thus defined.

Now raising the standard of superior individuals to the exceptionally great men such as Aristotle, Augustus, Newton, Bacon, Faraday, Franklin, Humboldt, Cuvier, Darwin, etc., of whom there are some two or three hundred known to history, I will give a second

one hundred dollars to the treasury of the American Genetic Association if a single one of them can be found in this three-generations-to-the-century class. Cyclopedias, biographies and biographical dictionaries give ample data for investigating more than a hundred of these cases.

The time limit on both of these offers will be December 31, 1914.

While I have investigated from many angles the question of the effect of age of parents on the offspring, I have never done the specific work called for by this offer. I am satisfied, from my general investigations on the subject, that no great man could have been produced under such conditions; but the person who hunts for the individuals designated will do something a little different from anything I have ever done. If the men are found, I will not regret the $200. I make the offer because I consider the problem involved to be of the highest importance, not only in eugenics, but in breeding any kind of animals.

For the purpose of general information and comparison, I append a table showing the distribution of births for two generations in the male line. It shows the ages of 2,564 grandfathers when grandsons were born, and the numbers of grandsons born at different ages of grandfathers. The figures were compiled from printed genealogies of New England families; and it will be admitted that the generations there are longer than they are in many parts of the world. Even there, it is evident that the general average of generations is more than three to a century. We should expect, on the laws of chance, that the illustrious men would fall in this class, in many cases at least. If they do not, there must be something wrong with such views as those expressed by Professor Johnson. If they do, someone can secure a contribution of $200 to the American Genetic Association by bringing forward the necessary data.

Ages of G. Fathers	No. of G. Sons	Ages of G. Fathers	No. of G. Sons	Ages of G. Fathers	No. of G. Sons	Ages of G. Fathers	No. of G. Sons
40	1	56	73	71	70	86	15
41	1	57	76	72	73	87	17
42	2	58	87	73	64	88	12
43	3	59	76	74	58	89	9
44	8	60	96	75	66	90	12
45	12	61	90	76	48	91	9
46	23	62	86	77	50	92	2
47	23	63	92	78	38	93	2
48	33	64	104	79	47	94	4
49	32	65	89	80	36	95	4
50	40	66	91	81	42	96	1
51	52	67	85	82	22	97	0
52	56	68	76	83	27	98	3
53	58	69	90	84	19	99	0
54	74	70	74	85	22	100	9
55	75						

Average for 2 generations $\frac{167330}{2564}$ = 65.26 years.

The Eugenic Ideal

The Founder of the Christian religion said, "I am come that ye might have life, and that ye might have it more abundantly." It is higher and more abundant life that is the eugenic ideal. Progress I define as the emergence and increasing dominance of the mind. Of progress, thus conceived, man is the highest fruit hitherto. He is also its appointed agent, and eugenics is his instrument.—C. W. Saleeby: Parenthood and Race Culture (1909).

THE JABOTICABA

Interesting Brazilian Fruit Little Studied but Presents Possibilities to Plant Breeders—Causes of its Cauliflory—Variation and Hybridization Under Cultivation.[1]

WILSON POPENOE,

Agricultural Explorer, Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

AMONG the many interesting indigenous fruits of central and southern Brazil, few create so strong an impression on the newcomer as the jaboticaba, not only because of its habit of producing its delicious fruit upon the trunk of the tree from the ground up, but also because of the unusual beauty of its symmetrical, dense, umbrageous head of light-green foliage, which entitles it to a place among the best ornamental trees of the region.

In spite of the popularity of the jaboticaba, which extends to all classes of Brazilians, and the fact that it has been cultivated for generations, the botany of this interesting fruit still remains in a state of confusion. As a general thing all jaboticabas are referred by horticulturists to *Myrciaria cauliflora* Berg, yet Berg[2] distinguished and defined three species, *M. cauliflora*, *M. trunciflora*, and *M. jaboticaba*, whose fruits are all known under the name of jaboticaba. Tavares, who gives a key for distinguishing these three species,[3] adds a footnote to the effect that the diagnostic characters will only serve to distinguish trees growing spontaneously in the forests, since culture produces marked variation from the typical characters, and in addition some of the cultivated varieties are the result of crosses between the different species. Barbosa Rodrigues,[4] another Brazilian authority, mentions two different species of *Myrciaria* whose fruits are known under the name of jaboticaba, distinguishing them by the fact that the fruit of *M. jaboticaba* is small and produced upon a short peduncle, while that of *M. cauliflora* is larger, and sessile; in addition the leaves of the former are larger than those of the latter.

To the student attempting to identify a jaboticaba found growing in a garden, the difficulties are numerous, and the whole subject seems involved in hopeless confusion. Not only must he deal with species, but the presence of horticultural varieties must be taken into account, in addition to the possibility of crosses between the different species, as mentioned by Tavares.

[1]The data contained in this article were collected on a recent trip of agricultural exploration in Brazil, in company with A. D. Shamel and P. H. Dorsett of the U. S. Department of Agriculture.

[2]In Martius, Flora Brasiliensis, Vol. 14, Pt. 1, p. 362. 1857-59.

[3]Tavares, Prof. Joaquim da Silva, in Broteria, Vol. X, Fasc. VI, p. 422. Bahia, Brazil and Salamanca, Spain, 1912. This key is as follows:

1. Peduncles of flowers and fruits quite long. Indigenous to Minas Geraes....	*Myrciaria trunciflora* Berg
Peduncles short....	2.
2. Leaves lanceolate or ovate-lanceolate, with the base obtuse. Calyx lobes ovate obtuse, ciliated. Indigenous to São Paulo and Rio de Janeiro....	*M. jaboticaba* Berg.
3. Leaves lanceolate, with the base acute. Calyx lobes lanceolate, acute, ciliated. Indigenous to Rio de Janeiro and Minas Geraes....	*M. cauliflora* Berg.

[4]Barbosa Rodrigues, J., Hortus Fluminensis, pp. 220-221, Rio de Janeiro, 1893.

A JABOTICABA TREE

One of the handsomest trees of Brazil, and highly prized on account of its delicious fruit. It seems to be adapted to a wide range of distribution in the tropics. (Fig. 11.)

GEOGRAPHIC DISTRIBUTION.

The geographic distribution of the jaboticaba is rather wide, ranging from Rio Grande do Sul on the south to Minas Geraes on the north, and from the Atlantic ocean to Goyaz and Matto Grosso on the west, a larger area than one would at first imagine from the propinquity of these states on the map. Outside of this region occasional trees are found in cultivation, as at Bahia, where the plant does not seem to be at home, however, and is rarely grown. Around the city of Rio de Janeiro the jaboticaba is one of the features of gardens and orchards, its dense, dome-shaped head of foliage, of an unusual shade of light green, marking it off from other fruit trees and making it a feature of the landscape. Not only single trees, but small orchards, sometimes an acre or more in extent, are not infrequent, being more common, perhaps, in the state of Minas Geraes than near the city of Rio. The esteem in which the jaboticaba is held by the Brazilians is attested by these orchard plantings, for in a country where the culture of tree fruits as a whole has not reached the stage where regular orchard plantings for commercial purposes are commonly made, the presence of a planting of four or five hundred trees of one variety proves the popularity of that fruit to be exceptional.

From the level of the sea the zone of the jaboticaba extends to altitudes of 3,000 feet or even more. At Petropolis and Nova Friburgo it grows and fruits well, as it does at Barbacena, in Minas Geraes, where the altitude is given as 1,168 meters. In this section of Brazil, however, the winters are not very cold

FRUIT GROWING ON LARGE BRANCHES

The berries are produced on every part, from exposed roots to the ends of small branches. Many tropical plants bear fruit on the old wood, while the habit is relatively rare in temperate regions; it seems possible that this habit is due to the softness of the bark, rather than to any adaptation caused by Natural Selection. (Fig. 12.)

even at such altitudes, and it is doubtful if the tree will withstand much frost. At Lavras, in Minas Geraes, ice is said to form occasionally, although the temperature for the last two years has not gone lower than 33° F., according to the observations of C. C. Knight of the Escola Agricola; in this region the jaboticaba must be given first place among fruits.

The name jaboticaba is a word of Tupi origin, derived, according to Martius[5], from *jabotim*, meaning turtle, the name signifying "like turtle fat," probably referring to the appearance and consistency of the pulp of the fruit.

[5]Beitrage zur Ethnographie und Sprachenkunde Amerikas zumal Brasiliens, Vol. II, p. 397, Leipsig, 1867.

Two spellings are current in Brazil at the present time, jaboticaba and jabuticaba being considered equally correct by some authorities, while others recognize jabuticaba as the best form. The word is usually pronounced by Brazilians zha-bu-ti-ca-ba, with slight stress on the fourth syllable. To designate the tree the suffix -eira is added, making the word jaboticabeira, or jaboticaba tree.

TREE LITTLE STUDIED.

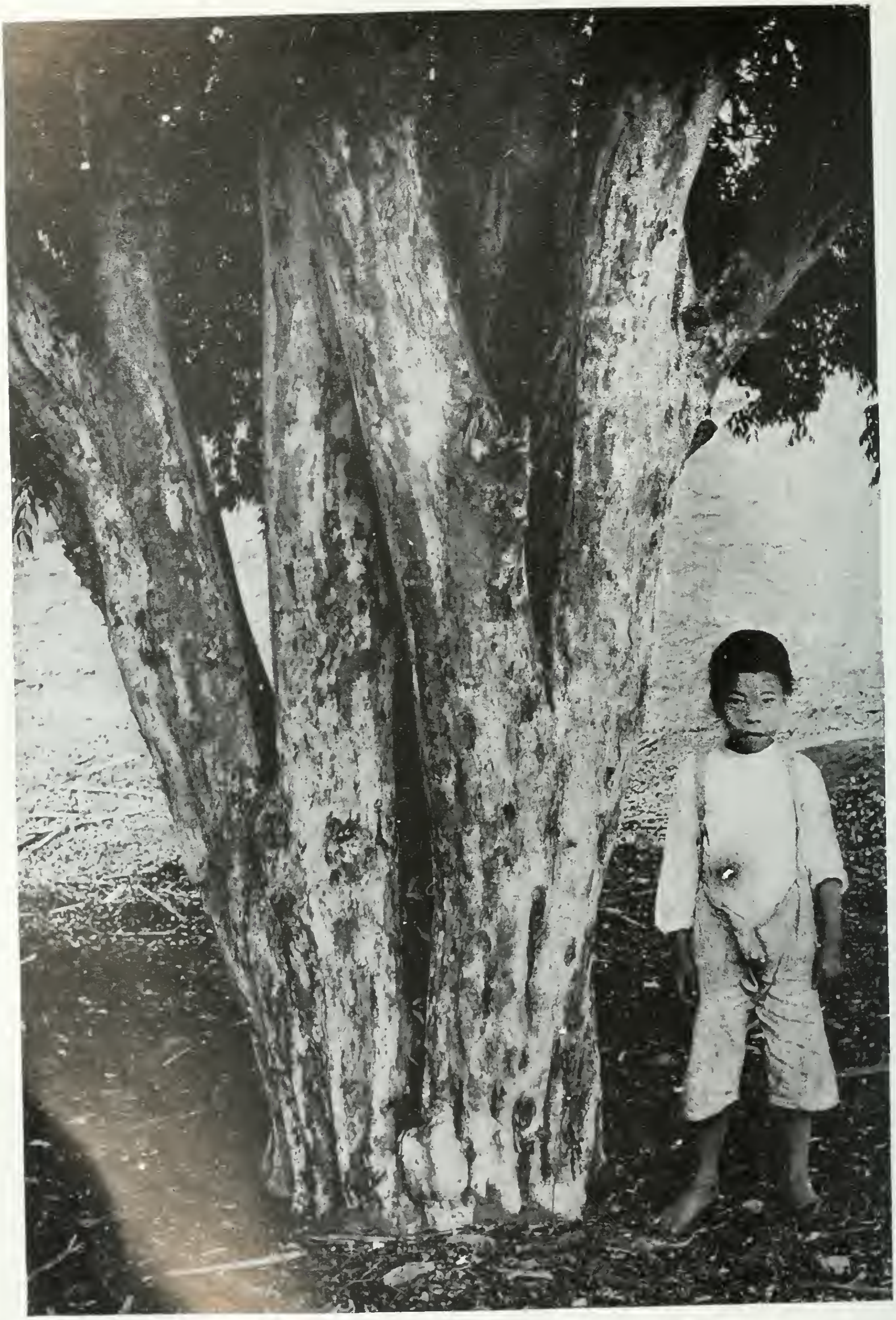
References to the jaboticaba in scientific literature are fewer than one would expect, considering the frequency with which the tree occurs in a large section of Brazil. One of the earliest and most interesting athough erroneous accounts is that given by Piso[6] in 1658, who says "It is a tall, erect, and elegant tree, bearing extensive branches; it bears an ash-colored fruit the size of a lemon, with sweet juice, and a very thin skin like that of very ripe grapes. It is wholesome and agreeable, especially to persons suffering from fever. It bears no flowers, but fruits from the bark, from the lowest root to the topmost branch and throughout the entire tree, close together in masses, so that the tree looks like one huge bunch of grapes, rather than a tree. A certain species of it grows in the forests of Pagi Tahuçurana, but bears fewer fruits as compared with the others. The natives express a sweet and delicate wine from it, which quickly ferments and turns into vinegar unless drunk. Both these trees are found in the vast forests of the interior, and are common in the prefecture of São Vicente, according to Emmanuel de Moraes. I must confess that I myself have never seen it, although I sought so elegant a tree with a good deal of diligence in the inland forests."

Barbosa Rodrigues considered the jaboticaba tree the most handsome of all the Myrtaceae. Under favorable conditions it grows to a height of 35 or 40 feet, the trunk nearly always branching close to the ground. The persistent leaves are opposite, ovate-elliptical to lanceolate, acute at the apex, generally glabrous, with the margins entire. In length they vary from three-fourths of an inch to over three inches, the size of the leaf being one of the characters by which the natives usually distinguish the different horticultural forms. The flowers are small, white, produced in clusters on the bark from the base of the trunk to the ends of the small branches, sometimes so thick as almost to hide the trunk from view. In form they resemble those of the myrtle, with four small petals and a prominent cluster of stamens. The normal season of flowering is said to vary with the different species; in the case of *M. cauliflora* Barbosa Rodrigues gives it as May in Rio de Janeiro, and in *M. jaboticaba* September. It is a common occurrence, however, for the trees to flower and fruit several times during the year, when they are in cultivation and supplied with an abundance of water.

DESCRIPTION OF THE FRUIT.

The fruit, which develops rapidly and ripens within two or three months after the time of flowering, is round or slightly oblate, half an inch to an inch and a half in diameter, deep, glossy maroon purple in color, crowned with a small disc at the apex. While sessile or nearly so in *M. cauliflora*, in *M. jaboticaba* the fruits are produced upon slender peduncles not over one inch in length. Between the two extremes in size there are all gradations, the fruits of *M. cauliflora*, which are considered the largest, frequently averaging about an inch in diameter as seen in the markets. The skin is thicker than that of the grape, and considerably tougher; it contains, beside coloring matters, a large amount of tannin. The translucent, juicy pulp, white or tinged with rose, is of a most agreeable vinous flavor, suggestive of the *rotundifolia* type of grape; this similarity to the grape is not confined to the flavor alone, the external appearance, character of the flesh, the size and number of the seeds as well as the flavor all bearing such a striking resemblance to the grape as to have earned for the jaboticaba the title of "the grape of Brazil." The flavor,

[6] Gulielmi Pisonis Commentarium in Iacobi Bontii Historiae Naturalis et Medicae Indiae Orientalis, Liber VI, p. 121, Amsterdam, 1658.



TRUNK OF JABOTICABA TREE

When trunk as well as branches are loaded with fruit, the sight is so extraordinary as to have caused an imaginative writer of the seventeenth century to declare that it looked more like a huge bunch of grapes than a tree. (Fig. 13.)

naturally enough, varies considerably with the species or variety, and one not infrequently finds a jaboticaba which has the disagreeable resinous twang common to several of the myrtaceous fruits; this may be due, in many instances, to the condition of the fruit at the time of eating and not to the variety itself. A good jaboticaba is so thoroughly agreeable as to tempt one to keep on picking and eating the fruits indefinitely,—a temptation to which, it must be confessed, Brazilians often yield. The boys, especially, will spend hours searching out and eating the fruits, and their only complaint is that it is impossible to satisfy one's appetite with jaboticabas.

The seeds vary from one to four in number, and are not easily separated from the pulp. In form they are oval to almost round, somewhat compressed laterally, one-fourth to three-eighths of an inch in length. The seed coats are thin and membranous.

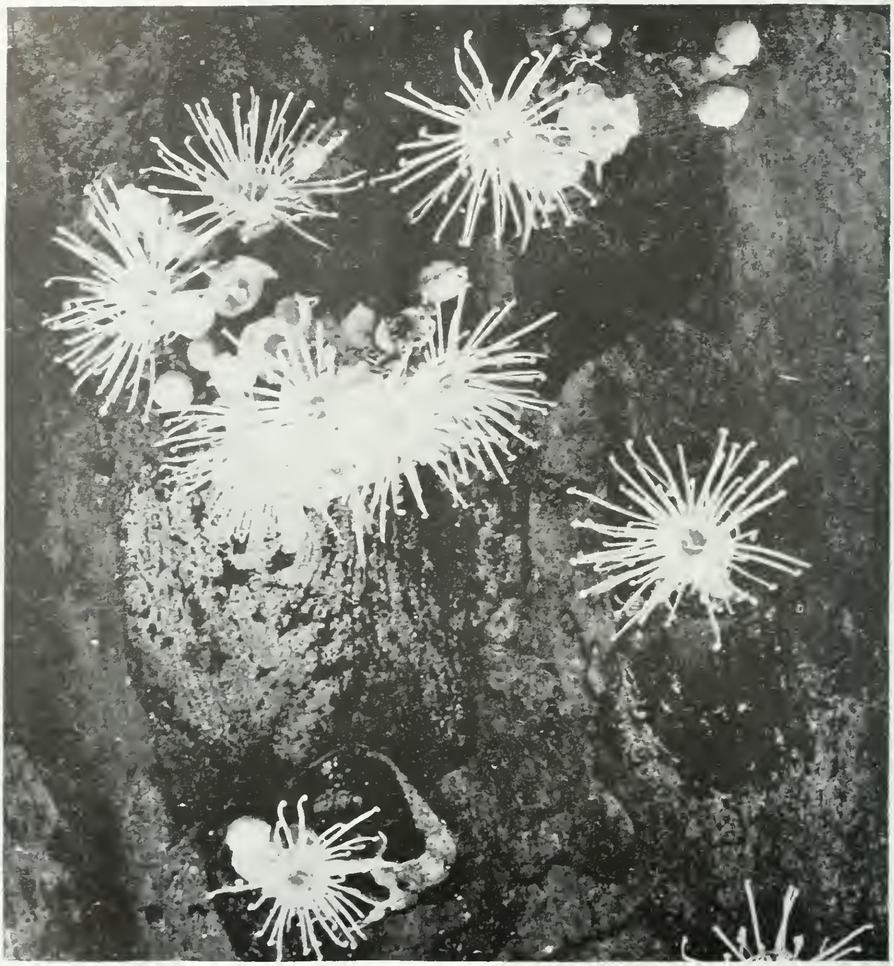
SPECIES AND VARIETIES.

A number of named varieties are known to the Brazilians, some of which are probably true species, others horticultural forms originating through seedling variation. The name jaboticaba, without any qualifying word, is considered to be properly applied only to *M. cauliflora*. In actual practice, however, this is not closely adhered to, since the natives of the lower classes use the word to designate the fruit of *M. jaboticaba* as well, although this latter is also known as jaboticaba de São Paulo, jaboticaba de cabinho, and jaboticaba do matto. Tavares mentions another species, *M. tenella* Berg, whose fruit is known as jaboticaba macia. The variety corôa, which is one of the commonest named forms recognized in Rio de Janeiro and Minas Geraes, can probably be referred to *M. cauliflora*. Another variety, murta, is equally well known, and has smaller leaves than corôa. No definite information concerning it is available, and as I have not seen it in fruit it is impossible for me to do more than venture a guess that it is another horticultural form of *M. cauliflora*. The native will often tell one that he has these two varieties in his garden, but when asked to define the difference between the two he is usually at a loss to name any distinguishing characteristic other than the size of the leaves. The variety branca is listed by one of the nurserymen in Rio de Janeiro, but no information concerning it is available other than that it is a small fruited variety. The name branca, meaning white, would indicate some difference in color from the common forms. Roxa, or red, is also applied to some jaboticabas as a varietal name, because of the fruit being lighter in color than usual.

The fruiting habits of the jaboticaba are worthy of more than passing notice. When heavily laden the tree is a curious sight. Not only is the trunk covered with clusters and masses of glistening jaboticabas, but the fruiting extends to the ends of the small branches, which all produce their share of the crop. When one stops to consider the small size of the fruits, and their abundance all over the tree, it is apparent that the number produced by a tree of large size must be enormous.

CAUSE OF CAULIFLORY.

Cauliflory—the producing of flowers upon the old wood—is not rare in tropical plants. It is difficult to see, however, of what advantage the characteristic can be to the jaboticaba, and what have been the reasons for its developing. Pollination has entered into the question, some authors having considered that the production of sessile flowers upon the old wood resulted in pollination by slugs. In the jaboticaba, however, this reason would not seem sufficient, since flowers are not only produced upon the trunk and large branches but upon the small branches and twigs as well. Neither is there any room for the argument that the fruits are too large and heavy to be borne upon the small branches and hence must be produced on the trunk, an explanation which has been offered to account for cauliflory in the jaca (*Artocarpus integrifolia* L., the jak of the Indo-Malayan region), whose fruits sometimes weigh as much as 40 pounds. Possibly



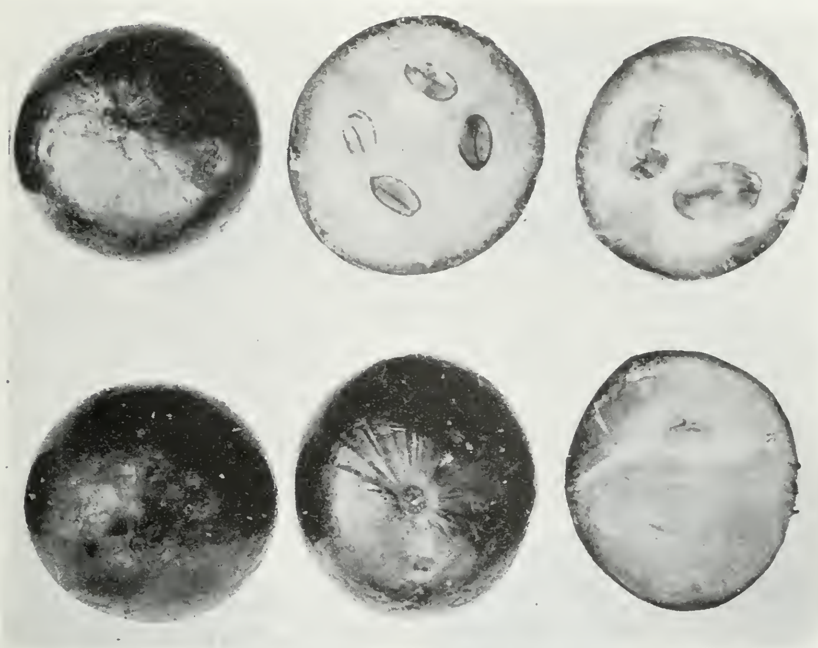
FLOWERS OF THE JABOTICABA

Twice natural size. They are similar to those of the myrtle, as the jaboticaba belongs to the order Myrtaceae. It has sometimes been supposed that the production of flowers on the trunk in this way was an adaptation to secure their pollination by crawling rather than by flying insects; but this argument seems to have no force in the present case, since flowers are produced on all parts of the tree. (Fig. 14.)

the explanation may be found in a statement of Schimper[7], who says "The question has often been raised why cauliflory is so much commoner in the tropics than in temperate zones, and the distribution has usually been associated with the conditions of pollination. To me it seems most probable that it is owing to the weaker development or less degree of toughness of the bark. This opinion is supported by the fact that in dry districts, where the bark is considerably developed and rich in fibers, cauliflory is very rare."

The season during which the jaboticaba ripens varies with the species and the location: sometimes, indeed, several crops a year are produced. The trees even flower and fruit during the winter months, in regions where the temperature does not go too low. Tavares considers humidity to be the essential factor, and states that the *fazendeiros* of São Paulo, who irrigate

[7]Schimper, A. F. W., Plant Geography upon a Physiological Basis, pp. 338-339, Oxford, 1903.



FRUITS OF MYRCIARIA CAULIFLORA

The largest of the jaboticabas. The pulp is juicy and in flavor greatly resembles the grape. In the markets of Rio de Janeiro such fruits sell for the equivalent of 25 cents a pound. Natural size. (Fig. 15.)

their trees at times when there is a scarcity of rain, succeed in having ripe jaboticabas throughout the year.

The methods used in marketing the fruit are somewhat primitive. Shipments are received in Rio de Janeiro from the interior, the fruit being packed in wooden boxes which originally contained two five-gallon cans of kerosene. No packing material is used, and the bulk being so great there is naturally much danger of the fruits being crushed and bruised in handling the boxes. If smaller packages were used much less injury would doubtless result; the tough skin of the jaboticaba enables it to be shipped considerable distances, provided a little care is used in packing. Since good jaboticabas retail in the markets of Rio de Janeiro at 1,500 reis (approximately 50 cents) a kilogram, there should be sufficient profit in handling this fruit to permit its being carefully packed and shipped in from distant points.

USES OF THE FRUIT.

While the jaboticaba is adapted to a number of different uses, at the present day practically all of the fruit seems to be consumed in the fresh state,—quite frequently direct from the tree. The almost passionate fondness which the Brazilians exhibit for this fruit seems to prevent their considering any other course than its immediate consumption the moment it is ripe enough to eat. By the aboriginal inhabitants of Brazil a wine was made which was held in high esteem. This wine is said to be made in small quantities at the present time, but it does not seem to rank as a commercial product. Jelly of excellent quality can also be made from the fruit. Frank R. Brainard, *chefe das culturas* of the Aprendizado Agricola at Barbacena, Minas Geraes, has recently experimented with this product to determine the best method of manufacture, and has found that the skins should be removed from about half of the fruits used, in order to prevent the jelly from having too strong a taste of tannin.

While the tree is said to succeed on any soil, it seems to prefer one that is rich and deep. Its growth is slow, six to eight years being required for it to

FRUITS OF MYRCIARIA JABOTICABA

These are distinguished from M. cauliflora by the presence of a slender stem, and are usually somewhat smaller in size. The color is a glossy purplish maroon. Jaboticabas are usually eaten out of hand, as grapes are in the United States. Natural size. (Fig. 16.)

come into bearing. In Brazilian orchards the trees are nearly always planted too close together, which prevents their attaining the large proportions they would otherwise reach. Frequently not more than 15 feet is allowed between the trees, whereas they should have at least 30. As previously stated, the jaboticaba withstands little frost, although it is without doubt hardier than many of the strictly tropical fruits, and adapted to cooler regions. In California some plants introduced about 10 years ago by Dr. F. Franceschi at Santa Barbara have made rather slow growth, and although at times slightly injured by the frost, give promise of being eventually successful in favored locations. Young trees in the U. S. Plant Introduction Garden at Miami, Florida, are doing well, and while it is yet too early to make any definite statement, they seem likely to prove adapted to this region.

In Brazil propagation seems to be exclusively by seed, although the foreman of one of the principal nurseries in Rio de Janeiro stated that he had successfully inarched young trees and considered this a desirable way to perpetuate choice varieties. Certain it is that some vegetative means of propagation must be used if improved varieties are to be established and perpetuated. The hard wood and thin bark will doubtless make budding difficult, but some form of grafting should prove entirely feasible.

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Date of issue of this number, July 25, 1914.

A HERD OF DUTCH BELTED HEIFERS

They show the standard pattern: note the remarkable uniformity in size and position of the belt, which is located in the same relative position as on the horse and the Indian Tapir. These Dutch Belted cows present a delicate problem to breeders, because the introduction of new blood, even though from a pure strain of the same variety, may upset the perfection of the pattern, just as is the case with the finest Barred Plymouth Rock fowls and Hampshire swine. Photograph from L. K. Hildebrand. (Frontispiece.)

COAT-PATTERN IN MAMMALS

A Medium of Real Value to the Breeder, Since it Enables Him by Analysis to Detect in Many Cases the Genetic Composition of His Animals—Mendelism in the Hands of the Fancier.

Q. I. Simpson, *Palmer, Illinois*

COLOR, or coat-pattern, is of little commercial importance on domestic animals destined for pail or plow, while it is entirely lost at skinning if the animal is destined for slaughter. Nevertheless, it has a real value to the fancier as a means of determining the purity of his breed, as well as to afford him a source of scientific entertainment. In the case of most pedigree breeds, pattern and color are an integral part of the standard score-card, and therefore must receive consideration from the breeder who handles pedigreed stock.

As the origin of most breeds is known, the latencies which they contain are of use to the analyzer. One of the most striking features which can be dealt with in this way is the white belt which is a feature of the colored coat of many mammals.

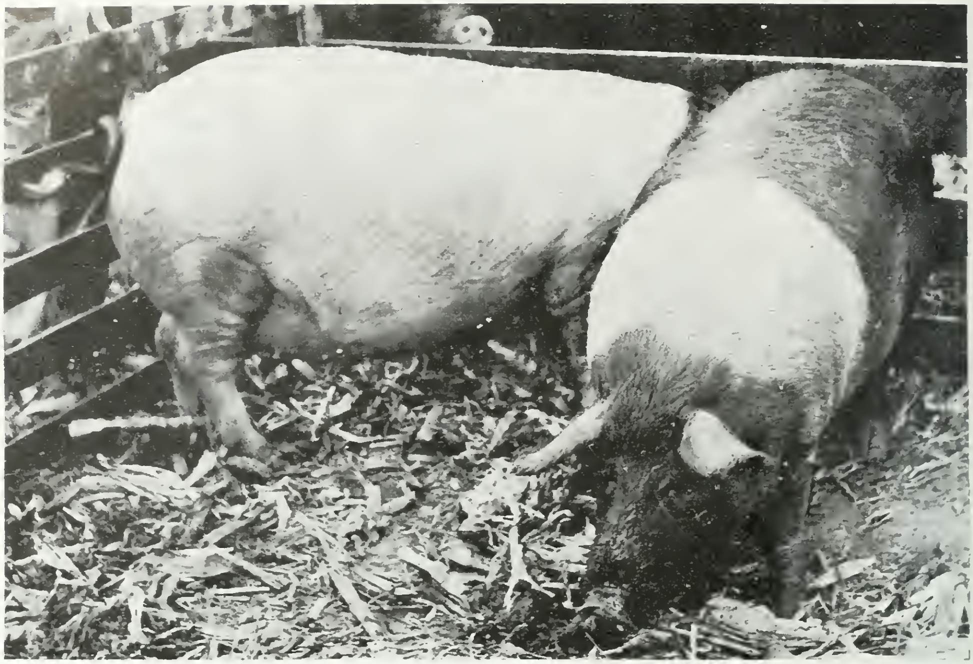
It is of relative location regardless of its dimension. In swine its center falls in the shortest line measuring over the shoulders from toe to toe, except in the latent belt of the Red Duroc, which is located farther back. So nearly in the same place is the belt regularly located on all swine, that it must be believed a peculiar cell-localization, belonging in general to all species of Suidae in latent condition.

W. J. Spillman of the United States Department of Agriculture was perhaps the first to publish a genetic hypothesis regarding the white belt in mammals, basing his opinion on his observations in my own herds of hybrid swine; and it is due to the stimulus received from him that I began to take an interest in this character. We had undertaken by reciprocal crossing of contrasted breeds to decide an important genetic question: the potential hereditary value of sex, the potency or hyper-potency of male or female. While this series of experiments was in progress, Mendel's Principles of Heredity were uncovered, adding more facts and greater fascination to the work.

FOUNDING A NEW RACE.

Among the hybrids on which we were working, we found synthetic belted pigs in the white contingent of the second Tamworth cross on White Yorkshire. Pigs with white hair but clouded skin, F1, were bred back to pure Red Tamworth, getting the straight Mendelian ratio of 2:2, whites and reds; but some whites remained white only until they were weaned. Red hairs then began to appear throughout the front and hinder areas, making in different subjects varying degrees of red-roan. Some even gained clean, white belts, located as in the Belted Black Hampshire. Looking back to these various belted red-roans, I now believe that clean red-end Belts could have been selectively evolved by interbreeding the reddest. In that case, my new race of Belted-Reds would have been better founded than by the method which actually produced them—namely, crossing these synthetic belts with the black-end Hampshire; for with the latter operation I lost time in cleaning away, by elimination, the Hampshire black.

Belted swine offer the seeming paradox of explanation by postulating one factor or two factors. An explanation will make this clear. Taking the red Tamworth, or the wild Sus from the Schwarzwald, any addition of the proper potential of unspotting white from a White Yorkshire will produce some clean white belts, with incipient pigment of the



A PRACTICAL PROBLEM FOR SWINE BREEDERS

Here is a pair of pure-pedigree Hampshire sisters from Dr. Flower's herd. The one at the right represents the standard pattern, the other shows an enlargement of the white belt until it covers the whole body, save for the head and tail. How can such an excess of white be corrected in breeding? Mr. Simpson says some breeders have used an all-black "throw-out" male for mating with sows of this type, and the results in the first generation are succesful. Relief is only temporary, however, for the second and third generations break away into black and white "throw-outs," just as is the case with Blue Andalusian chickens. (Fig. 1.)

outside area that delineates it. Then we might say that the white belt of swine is composed of a single factor, this dominant, and being simply the same factor that can produce a rather low potential of dominant white. But when a Belt is crossed, or white added, with breeds that exhibit, or carry latent, spots in the pigment area, it must then be compounded of two factors: one the white, the other a determiner for selfing the pigmented portion of the pattern. The first of these factors (the white) is dominant; the second (the selfing) is recessive.

Spotting on swine, as with other mammals, may be of two kinds: pigment spots on a white field, and white spots on a colored field. I can readily recall the founding of a noted breed of swine that was white with small black spots but now, by the selective fancy of its breeders, has gone through such an evolution that it has become nearly pure black, with a few white spots.

INHERITANCE OF BELT.

With a pure Hampshire male from President Goodwine, the white area of belt was dominant over some pure breeds, but in lower per cent. with cross-breds. The selfing was of vascillating recessiveness, verging to dominant in some crosses. From this boar on a pedigree Poland-China sow, that was clean black except the six white points, a brood of 13 pigs was born, all clean white in the belt of fairly uniform width; but seven of the litter were so much covered with spotting in the desired black area that they would not be taken for Hampshire hybrids.

As would be expected of white-face, stocking-legs, spotting, or pattern de-

THE BREEDER'S TEST FOR PURE PEDIGREE

A yearling sow, out of a tested Belted Red sow. and a supposedly pure Tamworth sire. Contrary to expectation, she has an all-white hind leg. Such a trait does not belong to either of her parents; Mr. Simpson is convinced that it shows a Berkshire taint in her supposedly pure Tamworth sire. (Fig. 2.)

pending on two colors, the width of white belt in Hampshire and its hybrids, or synthetic belts, varies in dimension from the entire pig white except head and rump, to all black except a narrow white line, or only the front feet white.

With the Hampshire of pure pedigree there are a few all-whites and some all-blacks. The factor for making white in the belt and the factor for selfing the anterior-posterior coat seem to be always in contest for supremacy: and both must be in happy equilibrium to produce the standard pattern. I have made apparent proof that either of these factors may be strengthened against the other by the conscious addition of other factors that work to the help of one of them. And illustrating:—Some red sows were selected that were the second Duroc top on Poland-China: out of a numerous bunch two sows were found free from white-spots or markings that indicate a hyperpotent red drowning the latent spotting of the Duroc and the white-spotting factor of the Poland-China. These all-red sows were bred to pure Hampshire, that normally should sire 100% belts: but the result of their 21 pigs was 11 self blacks and 10 belted of various but very narrow width, the ends of good Hampshire black. From other hybridizing with the same boar I believe that had we selected from the same broods as these hyperpotent red sows some others showing spots of white we would have gotten near 100% of Belts. We may say that both factors for belting pattern are Mendelian, but must provide that no other element interferes.

Belted pigs are occasionally met among several crosses free from Hampshire, Yorkshire or Tamworth blood. My recollection from childhood days, when my father was improving the native black hog of Illinois with a mostly white hog from Ohio, is that there was about 5% of belted pigs that were called by the settlers "listed-hogs." And in

Southern Indiana, where improvement was not undertaken until later, the Hampshire breed undoubtedly took its origin in the same way.

ANOTHER BELT FORMULA.

In searching for a belted-red male for outcross to my Belted-Reds, I found a pig without pedigree, of perfect belted-red pattern. He was from a herd in which the owner had variously used Chester-White and Red-Duroc males on a black Poland China foundation. Out of some 60 pigs he was the only one of the belt-pattern. Before using him we loaned him to a breeder having a large herd of sows that were a mixture of Duroc. Tamworth. Yorkshire and Poland in various proportion. In this herd he sired nearly 15% of belts, giving us some confidence that he would sire normally to our fixed-belt sows. But the result was no better than from the mixed herd, and we surmised his factors for the belt were compound and entirely different to the two-factor class with which we were breeding: acting against our older factors as opponent rather than aid. The few good belts from him were also sadly upset in their transmission, throwing pigment spots inside the widest part of the belt, white spots on the pigment area, white bellies and white high on hind legs (always on same pig with white-belly). May we suspect that his selfed area was the result of two different spottings, one interposed on the other, bridging the pigment voids?

Two broods by the Goodwine pure Hampshire out of two hybrid sows I will describe to illustrate pattern genesis:—These sows were of two Red-Tamworth tops on a pure white Yorkshire foundation: designated in farm-lore as ¾ Tamworth, ¼ York. In color-area one was a light-red-roan, the other dark-red-roan, and each had a normal white belt; their broods aggregated 16 pigs, enumerated:—Three perfect Hampshires; three wide belts on brown-roan ends; two standard belts on pale yellow-red ends, with a large black-spot on each at top of rump; two Hampshire-black with belts except these narrowed to extinction on each at top of shoulders; one good red coat with narrow belt closing at top of shoulders; one mostly white (an extravagant belt) leaving only a black spot on rump and at root of ears; one incipient belt, one fore leg only being white and the rest of the body good red except for small black specks on rump; three hair-coats all white, skins splotched with black.

Analyzing these:—the mothers were each heterozygous in the white factor for belting, getting this only from the Yorkshire side of their pedigree. That they were also heterozygous for the selfing on pigment area is proved by their roanness, of mingled red and white hairs, which came only from their last Tamworth cross. The white factor from the Hampshire was dominant in the entire 16 pigs in some degree, from the single white leg on up to the three pigs entirely covered with white. Had these same belted-roan mothers been bred to a sire of their own color and genesis, our like crossing has proved that their produce would have been 3:1 whites and reds, with a per cent. of the whites turning roan towards maturity, and some with belts.

ANALYSIS BY ANALOGY.

So far the analysis was simple: but looking at the result of adding the recessive selfing factor of the pure Hampshire with the various complements that this must encounter in these heterozygous sows, the combination can only be the crudest guessing. Again, however, we have precedent in other hybridizing. The Hampshire being full dominant to Tamworth Red, we may conclude that the first three pigs, named as perfect Hampshires, resulted from segregation of these breeds in the zygote. Actual breeding is the only test to determine whether they are heterozygous or homozygous for the white factor of the belting which, it will be remembered, is dominant. The next three pigs, brown-roan ends with wide belts, appear to be of Yorkshire-white plus the two belt-pattern elements from the Hampshire; except that there remained also in the ova one or more Tamworth pigment-forming genes which caused the

SOME COMPLICATIONS IN MENDELISM

Emma D. 71, a Belted Red sow, sired by a pure Red Tamworth boar out of a Belted Red sow, tracing back in the maternal line to a Hampshire boar on a light-roan-belted hybrid sow. Although she appears true to type she is of decidedly mixed descent. The question of interest to the breeder is to know how she will behave in breeding. She was mated to a Belted Red boar which was also a Tamworth-Belt hybrid, and farrowed 18 pigs. Eleven were belted, while seven were recessive reds. Had the parents been of pure blood instead of mongrels, all the pigs would have been expected belted. It is interesting to note that the black of Hampshire has been completely eliminated, both from body and germ cells, in this sow, as far as the analytical test of breeding shows. (Fig. 3.)

scattering pigmented hairs in the selfed area (the Hampshire selfing factor is recessive to pure White Yorkshire).

The next two pigs with their standard belts, pale diluted red at each end with a black spot in this on top of the rump, appear to have resulted from the pairing of enough Tamworth-red entities from the dam, which uncrossed would produce a highly potent yellowish-red, which is often found among the recessives of the F2 Tam-York cross. The added dominance of these two pigs was perhaps received from a single Yorkshire factor, with the dominant and recessive factors of the Hampshire sire.

The next two pigs, good Hampshires save that their belts narrowed to zero on top of the shoulders, should be classed with the first three of Tam-Hamp composition, only in these the selfing factor was more potent against the belting. The next two pigs, red with a narrow belt not continuous at the withers, are like the belts with yellow-red, except that the hyperpotent red from Tamworth, by Yorkshire acceleration, is yet more dominant against the Hampshire black. The next one, which was nearly all red with only the left fore-leg white, might be classed with the last foregoing, except that his belt was more incipient.

The last three pigs, with coats all white and skins mosaic, should be the result of crossing nearly pure white Yorkshire with the pure Hampshire. Evidently none of the Tamworth selfing factor was left in the conglomerate eggs.

We learn from these experiments and from direct crossing of the White

Yorkshire and the Red Tamworth, something of the elements that make each perfect in the colors belonging to its breed. And we also find that Mendelism may not be condemned without due analysis of contending factors that may be contaminating germ-cells. To make lucid I will try your patience with some meditating on Yorkshire and Tamworth color-origin.

THE YORKSHIRE WHITE.

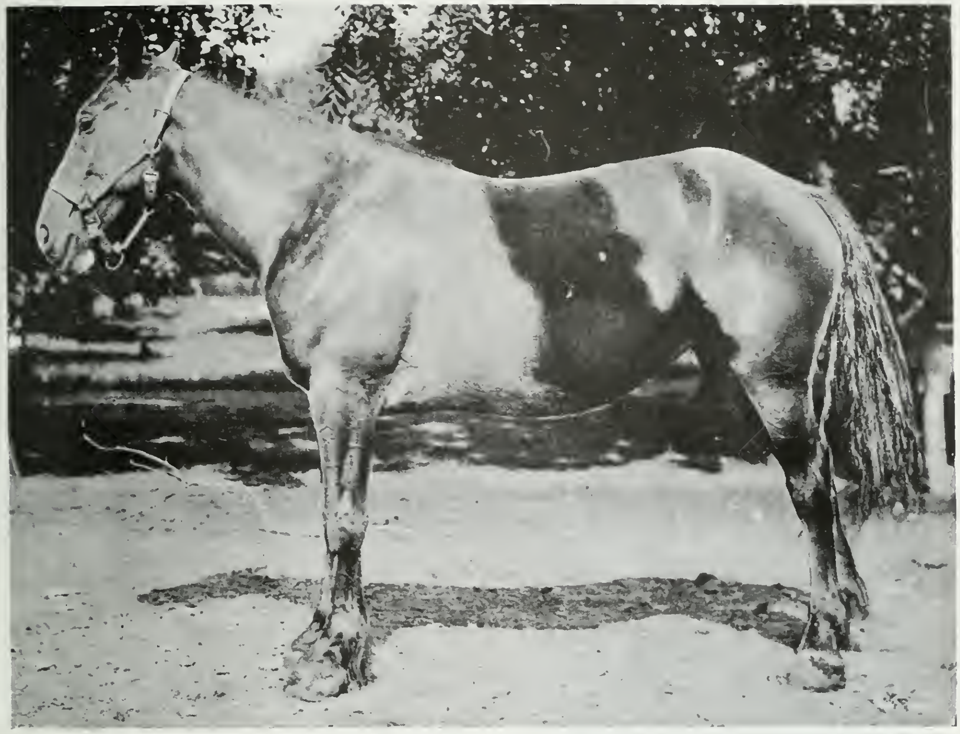
Yorkshire white must be treated as a pigment or coloring, the same as in the paint-shop, and not as the absence of something: for all white of swine known to me is dominant to the darker pigments, when crossed against them: analogous to the brown, red, and gray lead oxides that carbonated and further oxidized produce the whitest paint.

We would imagine the origin of the White Yorkshire that has some genealogy, to be from the white hog of China, where perhaps most of his perfection in whiteness arose before importation by the Bakewells to England. Being dominant white we can not suppose its first exhibit to be by the meeting of chromosome complements, as with albinos, (the pairing of two recessive chromosomes, one from each parent, making the somatic exhibit in purity). Nor may we guess that the first mutant was of such potentiality in dominance as is the single factor producing white in the family of spotted Negroes which I will later mention. Analysis of this Yorkshire white, which I have made by hybridizing, proves the main factor only to be dominant: and this the factor that singly, in heterozygous pairing, whitens every hair on the entire coat at birth, but has not the power to whiten the skin of the same subject. This single mutant factor could have acquired its present potentiality at a single leap, or may have reached its present stage by long continuous selection: we know of no analysis for deciding this. A single factor, by its presence or absence, says white hair or colored hair, as we have deduced by Mendelizing. But for the perfection of white in the skin from which the white hair grows, and the positiveness that all the hairs shall still be white at maturity of the subject, throughout the entire coat, we must postulate the doubling, or homozygous pairing, of the factor for white. We see in the jack-rabbit of the plains from Texas to Alberta, the progressive whiteness in which every degree of duration of Winter's snow adds to the perfection of his invisible snow-coat. And might not the white hog of China have gone through the same minute, selective steps of variation towards perfection, by the constant desire of his Mongolian breeders? That there is at least one factor in the Yorkshire of high oxidizing power is indicated by the fact that a portion of F_2 recessives of this breed and of the Tamworth, are richer in tint (red), and more potent in crosses, showing improvement over the red of pure subjects. Thus we find a perfection of "paint making" among the extracted recessive reds from the Tamworth-Yorkshire cross: a few of these being much more brilliant in exhibit, and more potent in further Mendelizing against other breeds.

The Tamworth, now desired a bright-red, is of lineal descent from the wild gray *Sus scrofa* of Europe. We know this from scattering history of his Irish origin, and have greater proof from hybrid analysis. It seems yet to require some selecting to prevent his reversion to the dark wild gray, now carried by the indigenous hog of the Schwarzwald. His skull-formation, though not his dentition, seems good evidence also of his *scrofa* descent. While the Tamworth is termed red, there are various shades and tints of this: a yellow-red that fades in maturity to dirty buckskin; bright-red keeping good to old age; and a ripe-cherry-red turning slaty-black at maturity of pig. And while the main factor that decides red is found in all the shades, there are no doubt other heritable factors shuffling in or out at formation of the gametes, saying by their presence or absence which particular tint will be made in the coat.

PATTERN CORRELATION.

Dropping back to the discussion of outlining in color-pattern with white and red, we will cite some observation:—



AN UNUSUAL HORSE BELT

Bright bay mare with a seal brown belt encircling the body in the position where piebald horses carry a white belt. The inheritance of this mutation was not tested further than two colts that were normal. Photograph by Spillman and Simpson. (Fig. 4.)

Two hybrid belted-red sows, one with belt on left side only, the other with belt only on her right side, and each devoid of white on opposite side where it should be white, were each bred to a pure Red-Tamworth male, causatively for ascertaining the action of orientation in the first two cells of the blastomere, and the polar localization of the front and hinder ends of the lateral pair of cells, to be determined by the pattern of their produce. To our surprise, in the goodly number of young from each sow there were no half-belts; and on those having preponderance of belt on one side, these did not correlate with the unsymmetry of their dam as to same side: for there were as many of right-maximum from the left-belt sow, and as many left-maximums from the right-belt sow. There were too as many perfect belts as from normal belt sows, under Mendelian expectancy. This could be explained on the assumption that the cytoplasm had effected pattern proportion at the two-cell stage of the unsymmetrical belts. If in the two-celled stage of development these had sundered, as is supposed in identical twins of man, these one-side belts would have each given phenomenon of "identical twins," one of each belted, the mate entirely selfed. I believe T. H. Morgan has found vinegar-flies (Drosophila) that had the right eye of one color and the left of another, and the same has been seen in man. We have, however, other evidence, that the size of spots in a pattern, and their location, is the effect of a lineal family of chromosomes, that at a fixed number of generations from fertilization reach differentiation. This is shown by paired anterior-posterior markings; and also by the fact that when a spot is found on one side, its mate at the same location may usually

ALBINISM IN MAN.

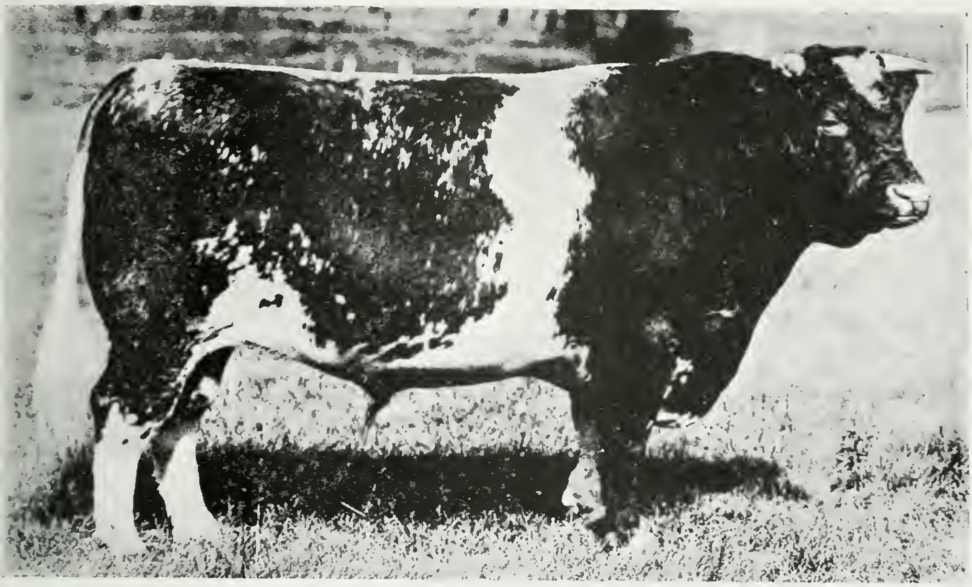
Seventeen spotted and 16 normal negroes are the aggregate descendants of Mrs. S.* A.*, a spotted mutation who founded a new race. This photograph represents her grandson, Jim D*., whose father was a wholly normal Negro. The white factor running in this family acts, in heredity, like the white factor for belting in swine, and is dominant. The width of the black stripe varies among the individuals, but all are white in front. Photograph first used by Simpson and Castle in the American Naturalist. (Fig. 5.)

be found on the other side. In several hundred observations of black switch on tails of Jersey cattle, no instance was found where the tongue was not also black; there are nearly as many Jerseys found with white switch, but these all have white tongue. An interesting subject was a heifer with a gray switch, (white hairs and black hairs being mingled in equal numbers), and the tongue was neither white nor black but a blended blue. This works also with the black-end Hampshire swine, where a few have undesired white on end of tail: nearly universally will it be found that the nose, sometimes only the center of the rooter, will be found of white skin. The pairing of white spots or black spots with near equality in size is found to some extent on nearly all domestic animals bearing spots on the coat: and only rarely, when the spot is quite small, will a mate not be found at the opposite side. This seems to prove causation.

The conception that size of color-area is dependent on the age at which differentiation occurs simplifies the phenomenon of pattern, whether the entire coat be a unit, or each individual feather of a fowl be the unit as with Barred Plymouth Rocks. With feather-barring, Oscar Riddle found that the white bars and the black bars were each all laid down on all the feathers belonging to the one bird as they were growing from the follicles at fixed minimum and maximum periods of the bird's body-temperature and blood-pressure: simulating the congestive coldness and subsequent fever-reaction of third-day malarial ague.

HETEROZYGOUS PATTERN.

When the pattern of individuals depends on the hybridity (heterozygosity) of paired chromosomes, it can not be heritably fixed: and concrete illustration is found with the roan-shorthorn, Blue Andalusian fowl, and at least two lines of spotted horses in America. With these horses (though not with the spotted Shetland pony, which is patterned by different factors from these), this spotting is the result of two



RINGMASTER, A GOOD TYPE OF ROAN SHORTHORN

The usual location of the belt in this breed is indicated. Neither the roan color nor the belt pattern can be heritably fixed, being the result, Mr. Simpson thinks, of a single white factor and a single red factor paired in the primordial sexual cell or zygote formed by the union of sperm and ovum. Roans are produced in 100% when all-red and all-white animals are mated; but when roans are mated together, only half of the produce are roans. In other words, the pattern is strictly heterozygous, according to the experience of breeders, but it can be created anew whenever it is desired, by the mating of pure white and pure red individuals to produce the required heterozygous pattern-determiner. (Fig. 6.)

equal and semi-dominant elements: one for making all white, the other for making all color; and these two factors are proved by breeding test to lie in the same chromosome pair. Thus when heterozygous, they create a spotted animal; when the white is doubled (homozygous), the individual must be all-white; when the color-chromosome is doubled the animal is selfed, and may be either bay, brown, chestnut, or black, according to its inheritance. The Mendelian ratio from a spotted mating is 1:2:1, white, spotted, colored: the same as the ratio from conjugating roan Shorthorns. Both the white and the self from spotted matings have proved, in my observation, pure and homozygous. The spotted Shetland acts like the spotting of pure Holstein cattle, and does not segregate. A peculiarity of the selfs from spotted matings is the absence of the usual white points, indicating that this selfing factor is different from the ordinary factor that produces standard colors in horses, most of which bear white markings on feet, legs or face.

Dr. Frank R. Lillie referring to Holsteins, of which for a number of years he has maintained an extensive herd of pure-breds, tells me:—"I believe that it is possible to breed for white or black, but results are surprising. One of our bulls (very white himself and of whitish ancestry) certainly puts more white on his calves from the same cows than the darker bulls. A pure black Holstein is an impossibility, I believe; if there is any black below the knees you can be sure of mongrel blood. The nearest we have come to pure white is in the case of a young heifer with a black tip to one ear and a black spot the size of a half-dollar on the neck. I think it would be possible to soon breed the black out."

Among the freaks of factor combinations which I have seen, was a percent. of striped-roan pigs, the produce of the second Schwarzwald-wild top on white

Yorkshire: these with seven longitudinal red stripes on a white-roan field were found in the clsss of dominant whites (at birth), acquiring the stripes after the weaning moult. At this time other important genetic problems prevented our testing the possibility of fixing the unique pattern. Its make-up was from the black birth-stripes of the wild scrofa, which are obliterated at moult, with a weak dominance of Yorkshire-white as the other factor: and a peculiarity was the fact that, unlike their prototype, the dark stripes became darker, the white-roan field whiter, as animal progressed in age.

We may safely predict that any form or design of color or pattern, be it belt, stripes, white feet, or spots in any particular locality, may be fixed to reasonable heredity dependent on homozygous pairs of chromosomes, regardless of the number of factors involved, so they fall inside of the species number of chromosome pairs. But no pattern or design can be regularly perpetuated where the factors are split in the pair, *i. e.*, when depending on any heterozygous pair of chromosomes.

THE USE OF MENDELISM.

Recapitulating we say:—The Fancier and the Mendelist may synthesize color and pattern to their likings. Starting with dominant white found on some individual, family, or race, among mammals or fowls, he may borrow from another of the species the dye, from yet another the stencil, and create unique marking. Then with simple Mendelian analysis will he prove, as with chemistry, the possibility of fixing to heritable perpetuity his hand-made design. When the particular type has been trued and standardized by selective elimination; homozygotized in each pair of chromosomes constructing it; and the race from which each pair of these was taken is known, then will he possess a delicate "C. P. reagent" for finding the most minute contamination in a suspect belonging to breeds with which he is familiar.

The fancier's Blue Andalusian is the hybrid of black and white; the spotted horse and the roan shorthorn are the hybrid dominants of white and color factors belonging to the same zygotic pair, always paramour in the sex cells and somatic cells: and such can never be fixed by breeder's selection: but they may be created *de novo* in 100% when an animal with one of these factors doubled is mated with another with the other factor doubled; so that at the halving of the chromosome pairs in egg and sperm to create the new life, this receives the paramour that creates the pattern.

Conceiving that areas of color markings are modified by the time of differentiation in the blastomere or embryo we then have a pleasing hypothesis for the fact known by feather-fanciers and pattern-breeders that the stable, standard pattern is upset when to a line of long inbred fowl or mammals an outcross of pattern of the same appearance is introduced. In my own experience and gleanings I find usually that the F1 individuals of the outcross are usually unchanged; the F2 and later generation show the bad breaking-up of color proportion and equilibrium. From this may we surmise that the nicely balanced barring on a "Felch" strain of Barred Rocks depends on exactly so many days and hours between the minimum body temperature and blood pressure, producing the white, and the same time period of maximum temperature and pressure producing the black, staining the colorless gell that is constantly passing out of the follicle. Then if there is introduced an out-cross of the "Barnes Strain" having a difference of congestive period, we would get the "breaking-up" of the correct barring by interposition of black on white.

Breeders of the now popular belted hog, the Hampshire, have not attended to the effect of outcrossing on their families, so that when they add new animals, the breeder of these has been accused of sending hybrids. May we moralize that the new dose must be cautiously tested before general use.

Let me add: that Mendelism, the result of chromosome shuffling and segregation at the sexual preparation of egg and sperm, is the breeder's fractionating column and analytical balance: it enables him to separate and weigh the determining entities that make visible the types, and then to resynthesize these to his uses and his fancies.

BIBLIOGRAPHY

W. E. Castle: "Heredity of Coat Characters," Carnegie Pub. No. 23, February, 1905; "Color Varieties of Rodents," Science, August 30, 1907; "A New Color Variety of the Guinea Pig," Science, August 30, 1907;—and Simpson: "A Family of Spotted Negroes," American Naturalist, January, 1913.

W. J. Spillman: "Inheritance of Coat Color in Swine," Science, October 5, 1906; "Color Inheritance in Mammals," Science, February 27, 1907; "Inheritance of the Belt in Hampshire Swine," Science, April 5, 1907.

Q. I. and J. P. Simpson: "Reversion," Science, March 15, 1907; "Genetics in Swine Hybrids," Science, June 19, 1908; "Analytical Hybridizing," American Breeders', Vol. VII, 1911; "Genetic Laws Applied," A. B. A. Vol. V. 1909.

O. Riddle: "Fundamental Bars in Feathers," Biological Bulletin, February, 1907.

G. C. and C. B. Davenport: "Heredity of Skin Pigmentation in Man," American Naturalist, November, 1910.

H. E. Jordan: "Microscopic Study of Melanin," American Naturalist, November, 1910.

H. H. Laughlin: "Inheritance of Color in Short Horns," American Naturalist, December, 1911, January, 1912.

J. H. Kastle and G. D. Buckner: "Asymmetric Color Resemblance in the Guinea Pig," American Naturalist, September, 1912.

A. L. Hagedorn: "Tri-Color Coat in Dogs and Guinea Pigs," American Naturalist, November, 1912.

T. H. Morgan: "Factors and Unit Characters," American Naturalist, January, 1913.

H. D. Goodale and Morgan: "Tri-Color in Guinea Pigs," American Naturalist, June, 1913.

C. C. Little and J. C. Phillips: "A Cross Involving Four Pair of Factors in Mice," American Naturalist, December, 1913.

E. N. Wentworth: "Color in Short Horns," American Breeders' Magazine, December, 1913.

W. W. Smith: "Color Inheritance in Swine," American Breeders' Magazine, June, 1913.

Hemophilia in Horses

That blood-vessel breaking in race horses is an inherited character is argued by J. B. Robertson in the *Bloodstock Breeders' Review* (II, 4, 265), who traces the beginning of the trouble to Herod, an English Thoroughbred foaled in 1758. Only one runner out of 400, each year, breaks a blood-vessel, but Mr. Robertson shows that the animals which do so are all found to be related, and apparently to carry this pathological factor as a recessive in either sex. Ordinarily, he remarks, "a true recessive character, such as chestnut coat-color, only becomes patent in the individual when a determining factor for it has been inherited from both parents," but it appears to him that "in certain characters which depend on structural or physiological peculiarities and which are marked departures from normality, one intense dose of the usually latent or abnormal character may be sufficient to overcome the normal condition, which has been inherited from the sound parent."

Inheritance in Poultry

Several suggestions regarding inheritance in domestic fowl are made by D. F. Laurie, poultry expert of the government of South Australia, in his report on Egg-Laying Competitions held at Parafield in 1913-14. "I would again impress upon breeders," he remarks, "that the reappearance of broodiness among White Leghorns is a taint, even as are cases of colored feathers. Both can be eliminated, but only by strict and accurate methods of breeding. . . . To breed from a hen which at any time has shown the slightest indication of broodiness is in my opinion the height of folly." The instinct to brood may be transmitted through the cocks, the breeder is reminded. Mr. Laurie also considers egg-shell color to be a transmitted character, subject to dilution or masking. There seems to be some correlation between tinted shells and broodiness. It is considered possible that the habit of laying tinted-shelled eggs appears only in alternate generations. Experiments are now under way which are expected to yield definite conclusions on these points.

THE EUGENICS COMMITTEE

To aid in guiding public interest in eugenics along scientific lines, and to increase this interest by propaganda, the President of the Association has appointed the following as members of the Committee on Education and Extension, which was created by the council of this association last winter:

David Starr Jordan, Chancellor of Leland Stanford Junior University, California (chairman).

Dr. Rupert Blue, Surgeon, General U. S. Public Health Service, Washington, D. C. (first vice-chairman).

Mrs. John Hays Hammond, former National Chairman, Woman's Welfare Department, National Civic Federation, New York, N. Y. (second vice-chairman).

Dr. W. C. Rucker, Assistant Surgeon General, U. S. Public Health Service, Washington, D. C. (secretary).

Irving Fisher, Professor of Political Economy, Yale University, New Haven, Conn.

Dr. Elnora Cuddiback Folkmar, Superintendent of Women's Auxiliary Clinic, Washington, D. C.

Mrs. Charles Cary Rumsey, New York, N. Y.

The Very Reverend Walter Taylor Sumner, Dean of the Cathedral of St. Peter and St. Paul, Chicago, Ill.

Talcott Williams, Dean of the School of Journalism, Columbia University, New York, N. Y.

Mrs. Huntington Wilson, Washington, D. C.

The letter of invitation sent to those selected as members (all of whom have accepted) states that "The object of this committee will be to promote the education of public sentiment throughout the country, in order that a 'eugenic conscience' may be formed in as many individuals as possible; to oppose premature legislation and, if necessary, to suggest desirable legislation, on the basis of scientific data. The work of this committee will be focused in the organ of the association, THE JOURNAL OF HEREDITY."

The committee expects to adopt every means possible to further the interests of conservative and constructive eugenics, but its principal work, for some time at least, will probably be the formation of local societies for the study of the subject, the arrangement of public meetings and lectures by men of science, and the publication of results of research which have direct application to the problems of human heredity. The committee will in this way supplement the Committee on Research in Eugenics of the American Genetic Association, and will also, it is hoped, occupy a new field, which has hitherto been left practically unoccupied, but in which there is the possibility of doing a great deal of useful work.

International Eugenics Committee

At the request of the Permanent International Eugenics Committee, whose function is to decide the time and place of each International Congress, and to act in a general deliberative and advisory capacity, President Fairchild of the American Genetic Association has appointed the following members to represent the United States of America: David Starr Jordan, Dr. Frederick Adams Woods, Dr. Rupert Blue, Charles B. Davenport.

Major Leonard Darwin is president of this committee, and Mrs. Gotto honorary secretary. The next meeting is to be held in London August 8. Belgium, Denmark, France, Germany, Italy, Norway and Sweden are represented on it, in addition to England and America.

RETICULAR HEREDITY

Heredity in a Network of Descent—A Conception Based on the Normal Evolutionary Condition of Species—Characters Represent Lines of Descent Rather than Independent Units in Germ-Cells.

O. F. Cook

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THE practical value of a scientific theory lies in its use as a method of thinking. Study of the general problems of heredity should enable us to think more clearly regarding the special problems that need to be solved in the interest of agriculture and the racial improvement of mankind. The danger is always that we allow our thinking to be governed by a few facts or by facts drawn from too narrow a field of investigation. Disconnected facts command only a limited interest, but a theory that suggests relations between different kinds of facts often stimulates interest and leads to further discoveries. The utility of a general theory, as well as its probability of truth, is judged by its application to a wide range of facts.

Assumptions or analogies that may appear thoroughly justified by one class of observations or experiment often need to be modified to bring them into agreement with data of other kinds. In this way there may be a gradual attainment of a better point of view, one that facilitates the study of all of the related facts. Yet these inductive methods of biological investigation often appear very indirect in comparison with the well formulated systems of the "exact sciences."

The study of heredity is often narrowed to a search for a "physical basis" or "mechanism of heredity." The morphological conception of plants and animals as made up of different tissues and organs has been carried over into heredity, and has suggested the idea of finding something in the germ-cell to correspond to the characters of the adult. The first investigators looked for a complete model of the next generation in the egg, and many similar hopes of finding mechanism of heredity among the organs of cells have been cherished, all to be abandoned in turn, with the progress of cytological discovery. The sex-chromosome hypothesis, suggested by cytological studies of certain groups of insects, is the most recent of these mechanical theories, but is now challenged by other investigators familiar with the cytology of the same insects. The results of breeding experiments are also at variance with the theory that the sex characters are transmitted in the sex-chromosomes.[1]

MECHANISM STILL HYPOTHETICAL.

If something in the protoplasm of the germ-cell could be shown to stand in a definite causal relation to some feature of the adult organism, we might begin to understand heredity in this physical, mechanical sense. But as yet we have no such basis of observation to warrant the localization of particular characters in particular parts or organs of the germ-cell. Indeed, we have no knowledge of characters except in their external manifestation, as features or differences to which attention may be directed in the study of heredity. Theories of heredity are still useful only as analogies and have to be judged by their consistency with general biological facts and their convenience as methods of thought, in bringing the

[1]Foot, Katharine, and Strobell, E. C. Preliminary Note on the Results of Crossing Two Hemipterous Species with Reference to the Inheritance of an Exclusively Male Character and Its Bearing on Modern Chromosome Theories. Biological Bulletin, 24: 187, 1913.

problems of heredity before the mind.

It is easy to admit in general terms that there must be something in the germ-cells to correspond to what we call characters in adult organisms, but to make this general admission is very different from forming a concrete idea of the hypothetical mechanism of heredity. We may be as sure as ever that organisms are machines, but reiteration of confidence in the general mechanical postulate does not give us increased insight into the machinery. The fact is that we are still without any definite indications of the nature of the unformed, rudimentary characters that are supposed to exist in the germ-cells. The many names that have been given to those hypothetical entities, such as pangen, determinant, id, character-unit, gen, etc., are merely symbols for the unknown quantities of biology. Their only use is for the statement of biological problems. Instead of writing our *x* with a single character as in algebra we use the symbol *gen*, with three letters. A gen is the unknown something that is assumed to represent a latent or unexpressed character; that is, a character as it is supposed to exist in the protoplasm, before it comes into expression during the development of the organism.

MENDELISM A MONOGENIC THEORY.

The so-called Mendelian theory of heredity is in reality a theory of the formation of germ-cells. To the assumption that characters are transmitted as separate particles or discrete entities of some sort, is added the idea that each germ-cell receives and transmits only a single set of these character-bearing "units."

The cells that build up the bodies of plants and animals, the so-called "somatic tissues," are supposed to contain two separate sets of character-units, or gens, derived from the two parental germ-cells that united in conjugation and initiated the development of the new organism. But with each return to the formation of germ-cells the two sets of gens are supposed to be broken up and redistributed in single sets. If the two series of gens derived from the parent germ-cells are alike, all of the new germ-cells have the same series of gens. But if all of the gens of the two parental series were not alike, the new germ-cells receive one or the other of the unlike gens, but not both. Thus the germ-cells of hybrids between different varieties or species are supposed to remain "pure" with respect to the contrasted characters of the parental stocks.

On account of this assumption of "pure germ-cells" Mendelism may be described as a monogenic or single-gen theory of transmission. Only one gen of the kinds required to produce the various features of an adult plant or animal is supposed to be represented in the same germ-cell. The failure of a parental character to reappear in some of the members of the second and later generations of offspring is explained by assuming that the character was transmitted to only half of the germ-cells. The theory does not provide for the transmission of additional gens to represent characters that may not be brought into expression, or that may give rise to unexpected variations in later generations. To explain such variations Mendelian writers resort to the theory of De Vries, that new characters and new species arise by mutations. If a sudden change of characters appears in a member of an otherwise uniform, "pure bred" stock, it is assumed that a new character has been formed, and that such changes in the characters of uniform groups are examples of normal evolutionary progress.

ORIGIN OF NEW GENS.

The effect of these theories is to return to the pre-Darwinian doctrine of special creation, except that the species are not supposed to be made altogether *de novo*, but by implanting the gens of new characters in members of old species. The change of any single character is supposed to establish a new "elementary species" or "biotype." How the new gens are made and substituted for the old ones is not explained, but the mathematical simplicity of the monogenic hypothesis and the idea that the chromosomes or other

internal organs of the germ-cells might represent actual, visible units of heredity, have proved very attractive, and have induced many recent writers to abandon the Darwinian conception of gradual evolutionary progress in natural species. Darwin was familiar with abrupt changes of characters, or sports, as he called them, but he did not consider them new species or examples of normal evolutionary progress. The doctrine of De Vries, supported, as it seemed to be, by the Mendelian theory of heredity, has been hailed as a great advance over Darwinism. But in some respects the new anti-Darwinian theories are logically inconsistent among themselves as well as lacking the support of pertinent facts. The more we emphasize the idea of characters as represented by definite pre-existent entities or gens, the more difficult it becomes to believe that new characters are suddenly implanted.

That workers in other fields of biology have been unable to accept the recent Mendelian and De Vriesian interpretations of the facts of heredity has not seemed a serious matter to those who were fully convinced by the statistical and cytological arguments. From this point of view it seemed a waste of time for "geneticists" to familiarize themselves with the natural species from which Darwin and his successors attempted to learn the nature of evolutionary processes. Indeed some writers have formally dismissed the idea of species as too vague and indefinite for the application of "exact methods." Instead of attempting to understand the development of new characters through the gradual evolutionary progress of species, attention is now given mostly to the changes of characters that appear in artificial pure bred strains under "experimental conditions."

But even this class of variations does not serve to support the monogenic conception of heredity. There is still no adequate proof of the most elementary assumption of the monogenic theories regarding hybrids and mutations, that one gen or character-germ can be taken out and another substituted, and leave the remaining characters the same as before. Mutations and hybrids have not been found to differ from each other by single characters as they are supposed to do in Mendelian and De Vriesian systems.

The fact that mutations commonly differ by many characters, instead of by single characters, was noticed several years ago, and was stated in a discussion of the difference between varieties and natural species[2]. Since that time many additional mutations and hybrids of cotton and other plants have been examined with this question in mind, but thus far without finding a satisfactory instance of monogenic mutation or mutative reversion. In all cases where a definite change in one character was noticed equally definite differences in other characters were found. Such facts indicate that mutative changes should be thought of as polygenic, that is, as affecting several characters at once, instead of assuming that they are commonly or typically monogenic, in the sense of being limited to single characters.

ABNORMAL MENDELIAN PHENOMENA

The nearest approach to monogenic behavior is found in cases of albinism or similar differences that may arise from simple chemical reactions. But certainly these color changes and allied phenomena afford a very narrow margin for the support of the general Mendelian idea of the existence of characters as independent units. Indeed, many Mendelian writers have virtually abandoned this idea of alternative units in adopting the "presence-and-absence" hypothesis to explain the results of Mendelian experiments. But if it be assumed that the Mendelian condition of alternative inheritance is a consequence of the dropping of normal characters out of expression, the Mendelian phenomena lose all constructive evolutionary significance and take their place among admitted abnormalities.[3]

[2]Cook, O. F., Mendelism and other Methods of Descent, Proc. Washington Academy of Sciences, 9: 235. 1907.

[3]Professor Castle has recently utilized this view of Mendelian characters as affording a basis for simplification of the Mendelian notation. See Castle, W. E. Simplification of Mendelian Formulae. Amer. Nat. 47: 170, 1913.

In reality alternative inheritance is not limited to characters that show the Mendelian reactions, but extends into other fields of heredity where the theory of germinal segregation and alternative transmission of unit characters does not apply. The sudden changes of characters often shown in successive internodes of the same plant are as abrupt and as definite as any mutative change or Mendelian alternation, and yet these changes of characters in internodes take place without any opportunities for the segregation and redistribution of gens in the formation of new germ cells, as required by the Mendelian theory of alternative transmission. Such changes of character, occurring during the development of the same individual plant or animal, must represent alternative expression of characters, instead of alternative transmission. And after this distinction is appreciated it appears reasonable to expect that other sudden changes or abrupt differences among the individuals of the same stock may represent variations in the expression of characters, rather than differences of transmission. Changes of expression must be considered in the study of heredity, as well as differences of transmission.[4]

THE POLYGENIC INTREPRETATION.

Instead of a single set of gens, as assumed in the theory of Mendelism, a multiple transmission of many alternative gens should be recognized, enough to represent the whole range of ancestral diversities. When the variations of domesticated stocks are compared with the diversities of related wild types the same general range of character is found. Many of the so-called "new characters" of mutative variations should be considered rather as suppressions or reappearances of old characters. The phenomena of reversion and recapitulation indicate that the transmission of characters is entirely independent of expression, and that characters may be transmitted in latent form for many generations and still retain their power of returning to visible expression.[5]

A polygenic interpretation of heredity does not conflict with the facts of Mendelism and mutation, and is in better accord with other facts of biology, both evolutionary and physiological. From a polygenic viewpoint, mutations and Mendelism appear as differences in the expression of the characters, rather than as differences of transmission. The mathematical formulae of Mendelism apply as readily to the expression of characters as to transmission and the polygenic conception of heredity enables us to avoid the misleading inferences that have been drawn from the monogenic theories. It no longer appears necessary to believe that the degenerate mutations of domesticated plants and animals represent new species, or even new characters. Uniformity in the expression of characters no longer appears to be the normal condition of heredity or of evolutionary progress. On the basis of a polygenic theory the typical condition of heredity, as of evolutionary progress, is found in normally diverse, freely interbreeding wild species, instead of in narrow-bred or self-fertilized domesticated varieties. The production of groups of uniform individuals by selective breeding or by special methods of propagation does not eliminate characters from transmission, but only regulates the expression of characters. It remains possible for the characters of remote ancestors to reappear in reversive mutations.

That characters should be transmitted in a latent condition may seem too wonderful for belief, but the fact remains that all characters are transmitted in a latent condition. The germ-cells, eggs, embryos, larvae and juvenile states do not have the characters of adults, except in the sense of transmission, nor do adults have the characters of the preliminary stages, except in the same sense of transmission to their offspring. It need not

[4]Cook, O. F., "Dimorphic Leaves of Cotton and Allied Plants in Relation to Heredity," Bulletin 221, Bureau of Plant Industry, U. S. Department of Agriculture, 1911.

[5]Cook, O. F., "Transmission Inheritance Distinct from Expression Inheritance," Science, n.s., vol. XXV, June 7, 1907. p. 911.

be considered more strange that a character should continue latent for a series of generations than that a seed should lie dormant for a period of years, expressing none of the characters of the plant, and yet losing none of them.

What we call characters may be, after all, only phases or stages in the development of the organism and may not be embodied in the protoplasm in any such manner as the corpuscular or genic theories have assumed. The larva or the embryo, the egg or the spermatozoon, is as truly an organism as the adult. Each form of life has its complete cycle and it is only an artificial, mechanical analogy that leads us to think of one part of the life-cycle as less complete than another. The cycle being continuous, each part can be considered as a preparation for the next, but in the very nature of the case there is no beginning or end.

If the idea of transmission seems to involve the notion of embodiment of the characters in the protoplasm of the germ-cells, we should see that this is only a deduction from the preconceptions with which we have approached the subject, and that it affords us no additional insight into the process of transmission. Until we have a working knowledge of the constitution of the protoplasm itself, the nature of the process of transmission can only be inferred from the facts of expression. Any inferences that may be drawn regarding the numbers and relations of the gens must accord with the behavior of the visible characters, and must accommodate the facts of heredity in networks of interbreeding lines of descent in natural species, as well as in single lines of descent in specially propagated domesticated varieties.

Domestication has been supposed to change the characters of plants and animals by placing them under different environmental conditions, but this factor is probably much less important than changes in the methods of descent. Where domestication has not been accompanied by restriction of descent, the normal state of individual diversity has not been lost, or given place to the greater diversity between narrow bred strains. In such cases as the rye plant or the Guinea fowl, where narrow breeding has not been practiced, the whole species remains relatively uniform and stable, in comparison with the species where descent has been restricted to narrow groups or to individual lines.

COHERENCE OF CHARACTERS.

Merely increasing the numbers of gens does not fully provide for the fact that many characters are usually changed together instead of one character at a time. Even assuming that there are many alternatives for each of the features of a plant or animal, there would still be no reason why the substitution of one of these alternatives for another should be connected with changes among the alternative gens of other characters. Our ideas of relations of the gens to each other have to be modified, in addition to recognizing increased numbers of gens. If we think of characters as representing stages and alternative courses of development, the gens, as predetermining rudiments of the characters, must be thought of as having intimate mutual relations, instead of being considered as entirely independent.

The tendency of characters to segregate or behave as independent entities, as manifested in typical Mendelian hybrids, is often counteracted by an opposite tendency to coherence or associated expression of characters. When the tendency to coherence is strong a whole series of characters may behave more or less like a single Mendelian unit, so that examples of coherence are often reported as cases of Mendelism.[6]

It may be nearer the truth to say that organisms different in one respect are different throughout, than to make the Mendelian or monogenic assumption that characters are separate entities to the extent that one character can be changed without affecting the others. The idea of alternative courses of development is in better accord with the general facts of biology than the idea of alternative gens, as shown by the

[6]Cook, O. F., Mendelism and Interspecific Hybrids, American Naturalist.

nature of individual differences among the members of normally diverse species, with free intercrossing of different lines of descent. We are familiar with diversity in the human species, and do not expect to find two individuals with exactly the same characters, except in cases of identical twins, and here the phenomenon of uniformity is ascribed to a division of the fertilized egg cell, analogous to vegetative propagation. As far as observation has gone, a similar diversity exists everywhere in nature, except where it is restricted by special methods of reproduction. To fit the facts of nature our theories must provide enough gens and in sufficiently intimate relations with each other to equip this infinite diversity of individual forms.

CHARACTERS AND LINES OF DESCENT.

Instead of trying to think of gens as separate entities or corpuscles of any sort we may think of them as parts of the ancestral lines that form the network of descent of the species. A better idea of the nature of the germ-plasm may be gained by considering it as a part of this network of descent. The cells that make up the bodies of plants or animals are connected into networks by delicate threads that pass through the cell walls, and the protoplasm inside the cells also has a reticular structure. Thus there is no lack of analogy for assuming a relation between characters and lines of descent. Indeed, we have all the phenomena of sexuality to warrant the suggestion of a physiological or causal relation between the network of the species and the network of the cell. As the crossing of lines of descent undoubtedly has a physiological function in increasing and maintaining the efficiency of the protoplasm, those who dwell on the idea of a mechanical basis for the phenomena of life should be the more ready to look upon the reticulum of the cell as representing the network of descent of the species. This relation or analogy allows us to consider the expression of each character as marking a stage in the development of the individual, and at the same time as corresponding to one of the many ancestral lines or alternative courses of development that are open to the members of a diverse species propagating itself in a normal network of descent.

Selective line breeding, self-fertilization, or vegetative propagation, enable us to establish definite courses through the maze of alternative paths of expression. When regularity of expression has been secured, so that all the members of a stock bring the same characters into expression, we have a uniform "pure" race. Uniformity has been accepted in the monogenic theory of Mendelism as representing the normal condition of heredity, though breeders know that uniformity is generally artificial, as well as temporary. Even in the most carefully selected stocks mutations continue to appear, the "sports," "rogues" or "black sheep" that are rejected because they do not follow the standard course of development. Thus the breeder's care is required to maintain the uniformity of a select stock, no less than to originate it in the first place.

The analogy between characters and lines of descent also allows us to think of successive appearances of the characters in the development of the individual as corresponding to their successive development in the evolutionary progress of the species. It is not necessary to suppose that the embryological record is entirely consistent or complete. New specializations, such as the larval characters of insects, may be intercalated into the early stages of the life history, instead of being added at the end. The extreme form of the recapitulation theory, that the embryonic and juvenile characters represent the exact courses of evolutionary progress, has been abandoned, but this need not interfere with the recognition of a general analogy or parallel between evolutionary development, or transmission of characters, and individual development, or expression of characters. Each character may still be thought of as a stage of development, reached by following one of the ancestral courses or lines of descent.

The conception of characters gained by this analogy is more concrete and

stands in a more effective relation with general ideas of evolution and heredity than any of the character-concepts that have been based on the wholly hypothetical "units." There is no objection, of course, to particularizing the characters in any way that the facts warrant, or to recognizing any ascertained relations to chemical substances or to physical conditions, but all this can be done without abandoning the general idea of multiple descent and multiple transmission of alternative ancestral characters.

CONCLUSIONS.

The Mendelian theory of heredity may be described as monogenic because it assumes the transmission of only one set of gens or character-units in each germ-cell. A polygenic theory is required to account for the fact that latent or suppressed characters are transmitted, as well as those that are brought into expression. The polygenic nature of heredity is also indicated by the fact that mutative changes of expression usually affect many characters at once, instead of single characters. A further advantage of the polygenic conception is that it allows characters to be brought into analogy with ancestral lines that form the network of descent of the species.

The assumption that characters are pre-existent in the protoplasm of germ-cells as discrete particles or independent units of any sort is not justified by observation or by logical necessity. Equally convenient and more truly biological methods of thinking about the problems of heredity can be developed by recognizing the relation of heredity to the network of descent of the species. This conception allows characters to be thought of as representing lines of descent instead of as discrete particles in the protoplasm.

Value of a Knowledge of Heredity

It seems to me that no kind of study can be made to bear intellectual fruit of nearly such value as the study of heredity. It lies at the root of every science and every study connected with life from botany and zoology to medicine, sociology or pedagogy. Who knows it not knows not life except in its superficial aspects. He may be a student of philosophy or a worker in biological science, but in these days when heredity enters so much into philosophy and links together so many biological sciences, he cannot be a very effective thinker or worker. It furnishes a master-key to the more tremendous events of history, and is our only hope against disasters that loom great and terrible in the near future. It goes deep down to the springs of human life, and thought, and conduct, and explains why some nations are inheriting the earth and the fruits thereof, while others are dying physically or mentally. The philanthropist must know something of this science or he will grope in the dark. The statesman must know something of it or he may labor in vain. Transcending all else in importance is the educational value of heredity. No nation in which a knowledge of it was widespread could possibly be stupid or brutal. The habits of thought which must be brought to its study are exactly those which counteract best the tendencies which have plunged so many nations into their Dark Ages. So few are the essential facts of heredity, but so prolonged, close and accurate must be the reasoning founded on them, that no great strain is placed on the memory while the reflective faculties are exercised in the highest degree. So largely would the student's learning link up with the subsequent experiences of his whole life that little would be forgotten, and a sure foundation would be laid for a clear and wide intellectual outlook.—G. Archdall Reid: The Principles of Heredity (1904).

INHERITANCE IN PLANT HAIRS

Stinging Bristles of Wild Plant—Black Tomentum of Velvet Bean—Fine Down of Lyon and China Beans—Coarse Down of Yokohama Bean—Stinging Bristles of Hybrids—Nine-Sixteenths of the Second Generation Stinging—Three-Sixteenths of the Second Generation with Black Tomentum on Plants and Pods—Fine, Coarse, and Intermediate Downy Pods—"Velvet" Plants—The Third Generation—Working Hypothesis.

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MUCH useful information has been gained by experiments on the inheritance of the color, length, and texture of hair, fur, or wool, in animals. Opportunities for similar experiments with plants have been rare. But in the second generation of crosses between the Florida Velvet bean and another species of Stizolobium[1], the Lyon bean, seven distinct forms of bristles, tomentum, and down cover the pods or other parts of the different plants; while the color of these plant-hairs varies between red, yellow, gray, white, brown, and black. Since each plant requires 64 square feet, there is no inducement to grow families solely for the study of the inheritance of the different kinds of pubescence. However, in raising improved constant races from the offspring of these crosses, considerable attention had to be given to the inheritance of the covering of the pods, and some of the main genetic differences have been disclosed. As several members of the American Genetic Association are investigating these plants, the following short account of my results may perhaps lead others to fill up gaps in our knowledge which I have been unable to fill as yet, although during each of the past four years the length of the rows of pedigreed plants I have grown amounted to about two miles.

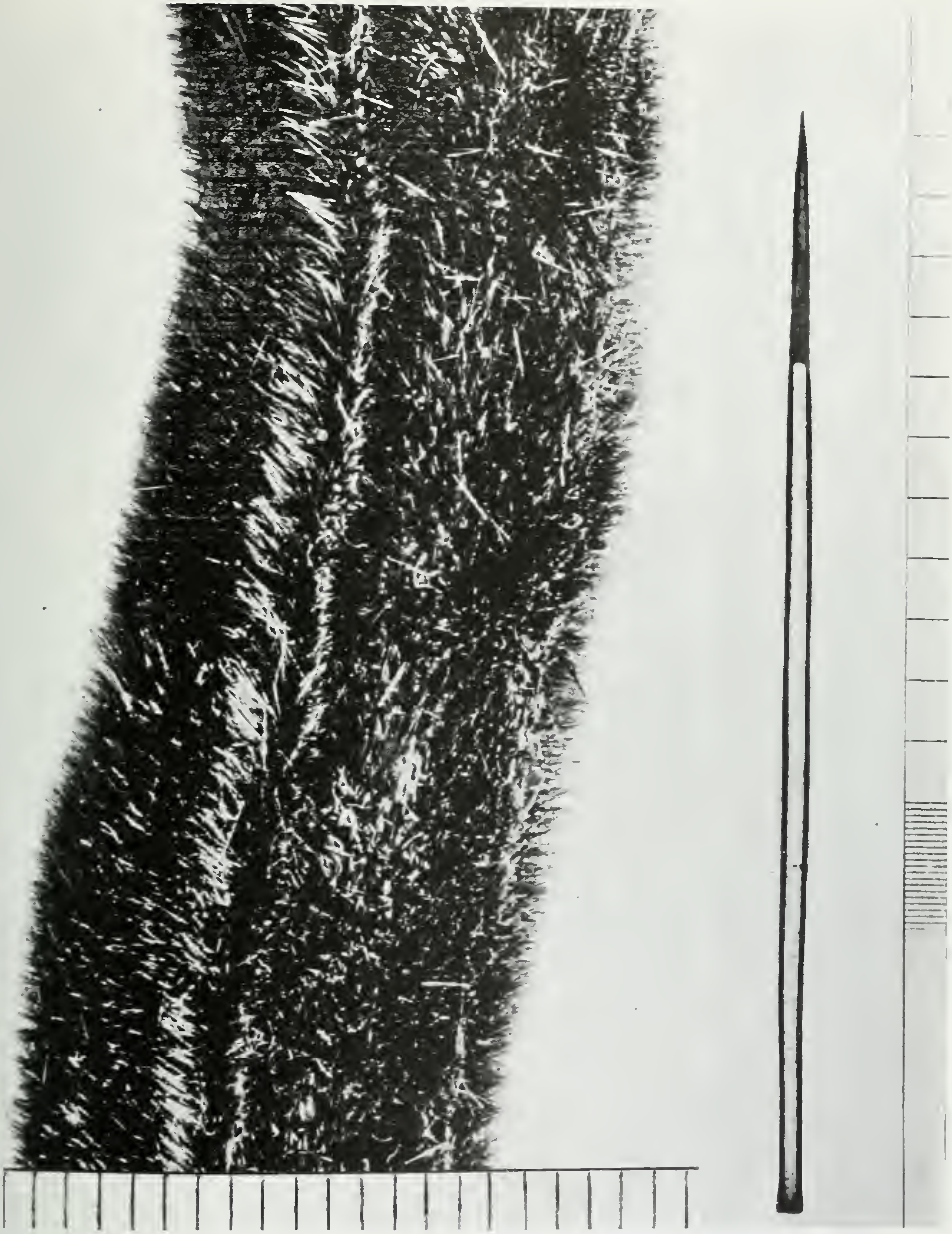
WILD STINGING PODS

A wild Stizolobium from India (*S. pruritum*) has its pods covered with red and yellow erect bristles less than two millimeters long. Part of a pod is magnified in Fig. 7. The bristles readily come loose. Each has its tip filled with a gummy substance, clearly visible in Fig. 7. The tip of the bristle is photographed on the left of Fig. 14. Minute projections like barbs may be seen. These projections form small colorless knobs over most of the bristle, but are longer and pointed near the tip. The two most conspicuous novelties resulting from the crosses were stinging bristles like those of this wild plant, and smooth black pods. These are shown, together with the pods of two parents, in Fig. 8.

THE PARENT PLANTS

The Velvet bean (Fig. 8*c*) gets its name from the nearly erect, black, silky hairs of its young pods. Its ripe pods are covered with a brownish-black tomentum or wool (Fig. 9, left), the flat twisted hairs of which are often over a millimeter long. One of these hairs is shown in the fifth place in Fig. 15. The fresh tomentum from a nearly full-grown pod is photographed in Fig. 11. Some of the hairs are straight and colorless, as are often the tips of the others. They have minute knobs, and also a little gum within the points. Men picking or threshing Velvet beans often experience irritation caused by the tomentum. If a genetic factor to stiffen and lengthen these weak hairs could be added, they would become genuine stinging bristles.

[1]These are described in Bul. 179 of the Bureau of Plant Industry, by C. V. Piper and S. M. Tracy.



STINGING POD AND BRISTLE

Magnified view, with millimeter scale, of part of the pod of *Stizolobium pruritum*, from India. The closely set stinging bristles are nearly erect. This pod was eight centimeters long. At the right is a photograph of a single stinging bristle from the pod shown, with scale in tenths and hundredths of a millimeter. The gummy substance in the tip is conspicuous. The minute dots seen, especially toward the base, are the colorless knobs referred to in the text. This bristle was reddish-yellow. (Fig. 7.)

FOUR TYPES OF STIZOLOBIUM POD

(b) is the China bean, whose fine down can be seen on the ridge along the center. (a) is from the first generation hybrid of Velvet by China, and is covered with stinging bristles, which are also best seen along the median ridge. (c) is the Velvet bean, covered by white-tipped, dark tomentum, while (d) represents the plants with fine black tomentum, which appear in the second generation and are called by the writer "smooth black." These pods seem glabrous to the eye, but the tomentum can be seen on young pods and (with a lens) in sheltered angles of the dry pods. This particular pod (d) came from a fourth generation plant. Photographs natural size. (Fig. 8.)

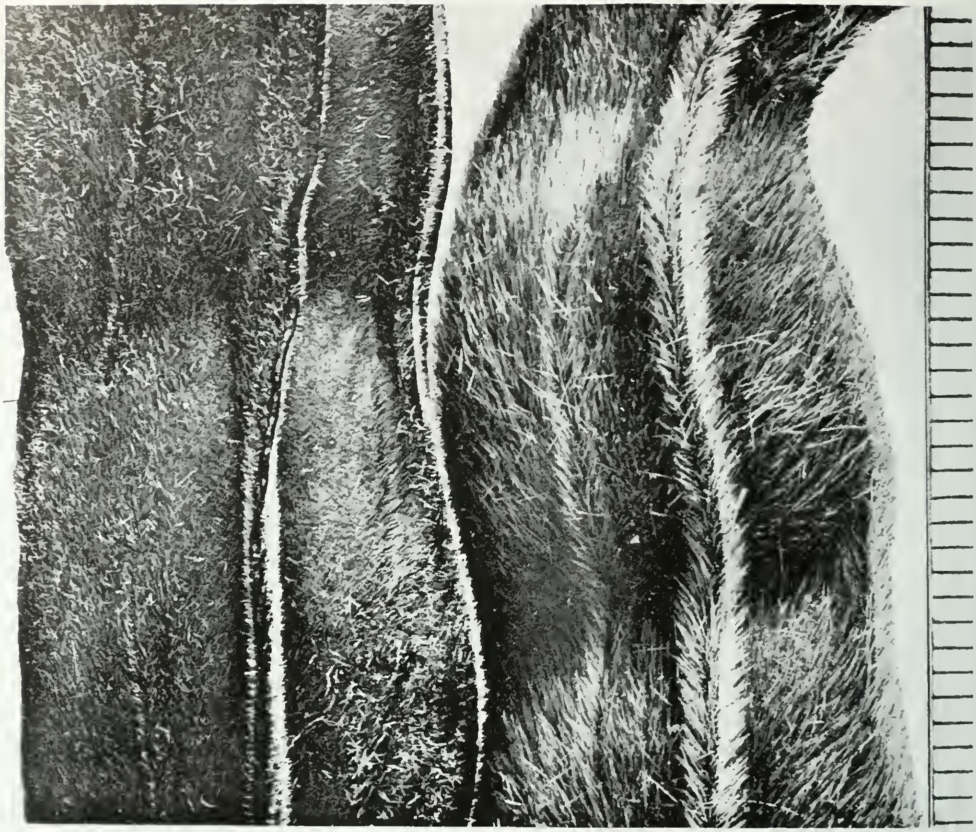
The blackish hull of the Lyon bean is made gray by an abundance of fine whitish appressed downy hairs, the longest of which are but little more than half a millimeter. A part of a pod is magnified in the center of Fig. 9. A single hair is seen in the second place in Fig. 15, and some of the fresh down from a nearly full-grown pod is photographed in Fig. 12. Even on these fine hairs minute knobs may be seen with the microscope, as well as a little gummy substance within the sharp tip. The down of the China bean resembles that of the Lyon, but is a trifle longer. Part of a China pod is magnified on the left of Fig. 10, and a single hair is shown in the third place in Fig. 15. The Yokohama bean has longer and silkier appressed down, which is usually yellower, but is otherwise similar. A part of a Yokohama pod is shown magnified on the right of Fig. 9, and a single hair of about the maximum length is photographed in the fourth place in Fig. 15.

HYBRID STINGING PODS

The pods of the first-generation hybrids of the Velvet with the Lyon, Yokohama, and China, are closely covered with more or less appressed stinging bristles, mostly grayish yellow, but usually with a patch of red at the base of the pod. One of the pods is

FINE DOWN, COARSE DOWN AND LONG TOMENTUM

The Lyon bean in the center shows fine down, the Yokohama pod to the right has coarse down, and the Velvet bean pod on the left has long tomentum. Scale in millimeters. (Fig. 9.)



FINE DOWN AND STINGING BRISTLES

This is a portion of Fig. 8, magnified. The fine down of the China bean on the left is to be compared with the stinging bristles of the F1 Velvet x China hybrid on the right. Scale in millimeters. (Fig. 10.)

shown in Fig. 8*a*. I am unable to distinguish the bristles from the three hybrids, even with the microscope. They are photographed, together with one from *S. pruritum*, in Fig. 14. These bristles are about one and a half millimeters long. The bristles of the first generation hybrids are shorter and thinner than those of *S. pruritum* and have less gum in the tip. They also sting less. A part of a pod from a first-generation plant of the Velvet by China cross is depicted on the right of Fig. 10. One of the bristles from this pod is photographed on the left of Fig. 15, its tip is shown on the right of Fig. 14, and a number of bristles are shown in Fig. 13. When, after the first frost in the fall, young stinging pods dry up, their pubescence becomes black, flattened, and more or less twisted, much like that of the Velvet bean.

THE SECOND GENERATION

The chief types of plant-hair appearing in the second generation are shown in Fig. 15. They are:

(1) stinging bristles, about one and a half millimeters, or more;

(2) fine down, about half a millimeter;

(3) coarse down, up to about three-quarters of a millimeter;

(4) intermediate between downy and stinging, about one millimeter (not shown);

(5) long tomentum over one millimeter long, like that of the Velvet bean, with a patch of black tomentum on the calyx, but white pubescence on the rest of the plant;

TOMENTUM OF VELVET BEAN

The fresh tomentum from a nearly full-grown pod of Velvet bean. Only a few of the hairs have become twisted. Mounted in water; scale in tenths and hundredths of a millimeter. (Fig. 11.)

(6) long tomentum, usually softer and blacker than No. 5, but accompanied with black tomentum over the whole of the plant;

(7) short tomentum, less than half a millimeter, accompanied by black tomentum over the whole plant and serious floral abnormalities.

(In the Velvet-Yokohama cross there were no *fine* downy pods.)

Some of the stinging plants had stouter bristles, some had stripes of red bristles on their pods like the wild *S. pruritum*, some had more erect bristles, and a few had sparse bristles. The color varied from yellow to gray, usually with a patch of red bristles at the base of the pod. Some few stung more severely than the first-generation hybrids.

Among the downy plants, the fine downy were greatly in the majority (except in the Velvet-Yokohama cross), but they graded into the coarse downy. Measurements of the hairs of nearly 300 plants under the microscope showed

DOWN OF LYON BEAN

The fresh down from a nearly full-grown pod of Lyon bean, mounted in water. A short basal cell in most cases accompanies the unicellular hair. Scale in tenths of a millimeter. (Fig. 12.)

had black tomentum mixed with the white pubescence on their young shoots. The color varied from grayish brown to brownish-black.

The black plants with long tomentum (long black) had sometimes tomentum on their pods almost as rough as that of the Velvet bean, but it was usually softer and blacker. It was sometimes sparse.

The black plants with short tomentum (smooth black) usually lost most of it from their ripe pods, so that they appeared glabrous and coal-black. In a few cases the tomentum was lighter brown.

Since more than half of the black plants set no pods, the ratio of long black to smooth black cannot be determined. Rather more than three times as many long black plants set pods in the three crosses, but the smooth black were distinctly later and more abnormal. Hence it is possible that the ratio is 2:1. The segregation appears in Table A.

In the first cross so many plants with white pubescence set no pods that the proportions are rendered unreliable. From the close agreement of the other two crosses with the calculated most probable numbers, we may be sure that the proportions are:

Stinging.		Downy.		"Velvet."		Black.
9	:	3	:	1	:	3

TABLE A

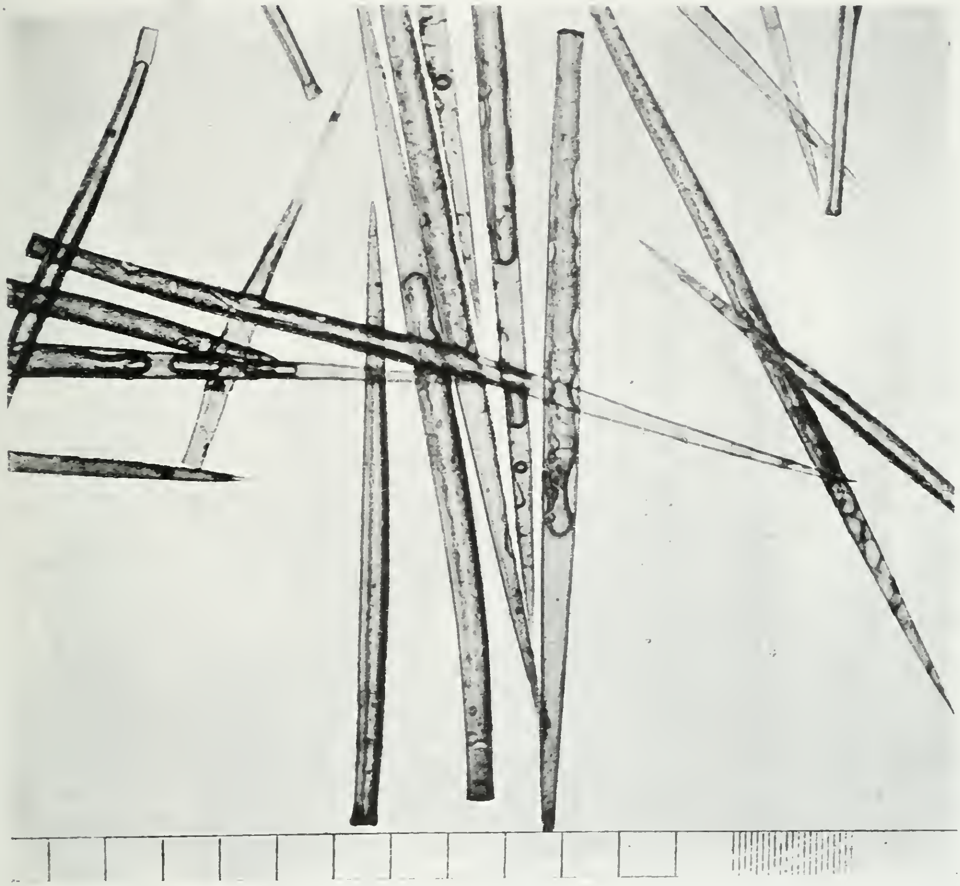
	White Shoots			Black Shoots.	White; *set no pods.*	Number of plants.
	Stinging.	Downy.	"Velvet."			
Velvet by Lyon.........	161.	40.	15.	62.	38	316
Calculated............	156.4	52.1	17.4	52.1		
Lyon by Velvet.........	320.	107.	34.	102.	8	571
Calculated............	316.7	105.6	35.2	105.6		
Velvet by Yokohama....	231.	72.	25.	75.	4	407
Calculated..........	226.7	75.6	25.2	75.6		
					Total...	1,294

that the intermediate formed only about one-twelfth of the whole number of downy plants. A minority of downy pods had more or less erect hairs, and a few had sparse down. The hairs were either yellowish or white.

The "Velvet" plants had sometimes stiffer tomentum than that of the Velvet bean, and more straight hairs. Some

THE THIRD GENERATION.

STINGING PLANTS.—Thirty-six stinging plants, from the second generation of the Velvet-Lyon cross, had the majority of their surviving progeny in each family stinging, when their seeds were grown among crowded sorghum in an elimination test (*see* Rept. of the Fla. Agr. Exp. Sta. for 1912, pp. 115-127).



STINGING BRISTLES OF HYBRID

Bristles from a ripe pod of the Velvet x China F1 hybrid, mounted in water. Most of them contain air. Scale in tenths and hundredths of a millimeter. (Fig. 13.)

Black plants were seen in several families, but apparently none survived to produce pods. Sixteen of these 36 plants had 15 or more survivors. Out of these 16 families,

(1) 3 were all stinging;
(2) 9 were stinging and downy;
(3) 3 were stinging and "Velvet";
(4) 1 was stinging, downy, and "Velvet."

The calculated numbers are:

(1) 1.8 families, constant stinging;
(2) 3.6 families, 3 stinging to 1 downy;
(3) 3.6 families, 3 stinging to 1 long tomentum (mostly "Velvet," a few long black);
(4) 7.1 families, 9 stinging to 3 downy to 1 "Velvet" to 3 black (or recessive downy).

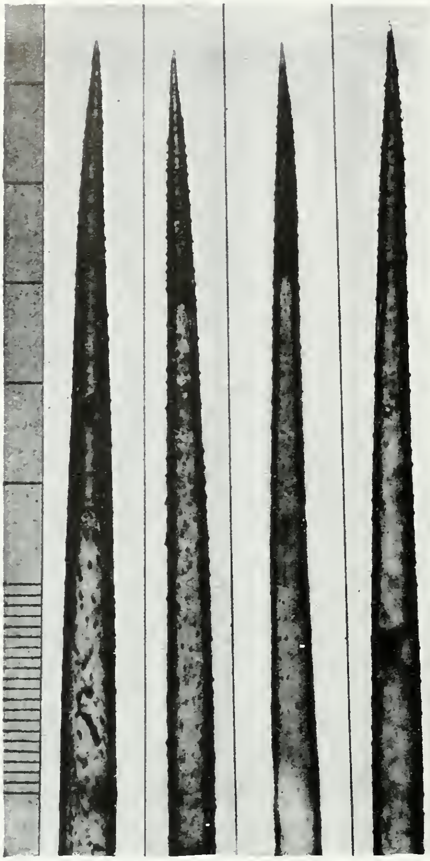
The elimination of the black plants would cause a few of class (3) to appear as class (1); and, together with the small size of the families, would cause most of class (4) to appear as class (2). Hence the numbers of different classes of families of stinging parents point to a segregation with two main factors.

DOWNY PLANTS.—Out of 22 families, six were constant; and 16 segregated into downy and smooth black. Fourteen of these segregating families were grown on poles. Their totals were:

	Downy	:	Smooth Black.
	311	:	118
(Calculated	322	:	107)

From seven downy plants of one of these F3 families, seven families were raised in F4. One was constant, and six segregated as follows:

	Downy.		Smooth Black.
	157	:	57
(Calculated	160.5	:	53.5)



TIPS OF STINGING BRISTLES

The first is from the wild *S. pruritum*, and contains much gum in the point. The second, thirdand fourthare from F1 plants of Lyon x Velvet, Velvet x Yokohama and Velvet x China, respectively. They are indistinguishable, and contain less gum. Scale in tenths and hundredths of a millimeter. (Fig. 14.)

From one of these smooth black plants, a constant seedling family was raised in F5.

Hence the segregation of the progeny of heterozygous downy plants is,

Downy.		Smooth Black.
3	:	1

Figs. 16 and 17 show respectively downy and smooth black plants of the fourth generation. A pod of one of these smooth black plants is shown in Fig. 8*d*. The pods of these particular downy plants were not unlike the China pod shown in Fig. 8*b*.

"VELVET" PLANTS.—Out of five families, three were constant "Velvet," and two segregated into,

	"Velvet."		Recessive Downy.
	21	:	7
(Calculated	21	:	7)

The recessive downy plants have long appressed silky down (up to one millimeter) on their pods, and a patch of black tomentum on the calyx like the "Velvet" plants.

From a "Velvet" plant of one of these families, two families were raised in F4 and F5, which segregated into,

	"Velvet."		Recessive Downy.
	33	:	10
(Calculated	32	:	11)

From one F4 recessive downy plant, a constant family was grown in F5.

Hence the segregation of the progeny of heterozygous "Velvet" plants is,

"Velvet."		Recessive Downy.
3	:	1

LONG BLACK PLANTS.—Only three families were grown in the third generation. Their parents were selected for maximum crop. One F2 parent with weak tomentum gave in F3,

	Long Black.		Smooth Black.
	35	:	15
(Calculated	37.5	:	12.5)

Two F2 parents with stiffer tomentum gave in F3,

	Long Black.		"Velvet."
	44	:	17
(Calculated	46	:	15)

From one of these last families, several families were grown in F4 and F5. Most of the long black segregated, but some were constant. The "Velvet" were constant.

Hence the progeny of some of the F2 long black plants segregates into,

Long Black.		Smooth Black.
3	:	1

Others segregate into,

Long Black.		"Velvet."
3	:	1

Most of the F2 long black plants yield very poor crops.

VARIETIES OF POD HAIR

The first is a typical stinging bristle from the Velvet x China hybrid. The second and third are typical fine downy hairs from the Lyon and China beans, respectively. The fourth is a long, coarse downy hair from the Yokohama bean. The fifth is a hair of long tomentum from the Velvet bean. The sixth is one of the longest hairs of the fine tomentum on the smooth, black pods found in the second generation hybrids. Scale in tenths and hundredths of a millimeter. (Fig. 15.)

FINE DOWNY PLANT

A fine downy plant of the fourth generation, photographed early in September, and flowering freely. This belonged to the family of VL-515, of which seven lines were grown in F4. One of these gave 51 plants resembling this one, with fine downy pods; and the six others gave 157 plants like this and 57 smooth black plants such as shown in Fig. 17. There were thus in the field 208 plants, all closely resembling the one photographed above. By November, all these plants were bare of leaves and covered with dry pods. They were a week or two earlier than the Velvet bean. The hairs on shoots and leaves are white; the leaves are distinctly wrinkled. Scale in feet. (Fig. 16.)

SMOOTH BLACK PLANT

This plant belonged to the same family as the one shown opposite. Six fine, downy F3 plants gave each in F4 about one-quarter of these black plants. This photograph was taken early in December, 1912, but the plant presented much the same appearance early in September. This particular black plant set *no* pods, as all its minute flower-buds, or its few flowers, dropped. Some of the 57 black plants (brothers or first cousins of this one) set a few pods, but *all* kept their leaves until the frost of December 26. The leaves are smooth and convex; all the hairs on the plant consist of black tomentum. Scale in feet. A remarkable segregation with a single factorial difference. (Fig. 17.)

SMOOTH BLACK PLANTS.—Seedling families were raised from three F2 plants which produced enough ripe seeds. One family was constant black, and two families segregated into,

	Black.		White.
	53	:	18
(Calculated	53	:	18)

Hence the progeny of heterozygous smooth black plants segregates into,

Black.		White.
3	:	1

The pods of these recessive white plants have not been seen. Most of the F2 smooth black plants yield no crops.

WORKING HYPOTHESIS.

If B is a positive genetic difference (or factor) which the Velvet bean lacks, but which is present in the Lyon, Yokohama, and China; and C is another genetic factor, present in the Velvet bean, but absent in the other three; and *both* B and C (either single or double) are needed for the production of typical stinging bristles; then in the second generation,

(1) The stinging plants have both the factors B and C, single or double,
(2) The downy plants have only the factor B, single or double;
(3) The long black and "Velvet" plants have only the factor C, single or double;
(4) The smooth black plants have neither B nor C.

If D is a genetic factor, present in the Lyon and Yokohama, but absent in the Velvet bean, which factor, in the absence of B, causes the formation of black tomentum all over the plant; if between factors C and D there is a partial repulsion, so that they *rarely* enter the same gamete; then,

(1) Plants with neither C nor D will be very rare in F2;
(2) Plants with both C and D will be about twice as numerous in F2 as plants with only C; most of the former will have single, and most of the latter double factors;
(3) Plants with D only will mostly have this factor double, and will be about half as numerous as plants with both C and D.

We have then for the segregation in F2:

(1) Nine-sixteenths, stinging plants, all with B and C, about two-thirds with D (mostly single), and about one-third without D;
(2) Three-sixteenths, downy plants, all with B, and nearly all with D (mostly double);
(3) Three-sixteenths, plants with long tomentum, all with C, about two-thirds (long black) with D (mostly single), and about one-third ("Velvet") without D;
(4) Nearly one-sixteenth, smooth black plants, without B or C, all with D (mostly double);
(5) A very few, recessive downy plants, without B, C, or D.

This hypothesis needs confirmation, especially by crossing and back-crossing the constant lines in F6.

Eugenics Research Association

The Eugenics Research Association, an organization composed largely of field workers on various cacogenic lines, held its second annual meeting at Columbia University on June 19 and 20, with an attendance varying from 50 to 75. A number of good papers were read, and much time devoted to a discussion of practical problems, during which considerable dissatisfaction was expressed with the idea that feeblemindedness is a "unit character," Professor R. S. Woodworth of Columbia University declaring that eugenics could not hope to gain the support of psychologists until it had either proved or abandoned this hypothesis. Professor J. McKeen Cattell of Columbia University was elected president and William F. Blades of the Eugenics Record Office re-elected as secretary-treasurer. Dr. Jean Weidensall of the Laboratory for Social Hygiene, Bedford Hills, N. Y. and Dr. A. J. Rosanoff of Kings Park Hospital, N. Y., were chosen as directors to fill three-year terms.

THE DECLINING BIRTH RATE

Better Classes of Population in United States Marrying more Frequently and at Earlier Age than in the Past, but Number of Births Decreases—Cause of Fall Mainly Psychological—Interests of Individual Versus Interests of Race.

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IT IS a self-evident fact that when death-rates begin to exceed birth-rates in any race or nation it is only a matter of time until that race or nation is supplanted by another in which there is an annual increase in numbers. History shows that racial stocks with a redundant fertility have flowed out from ancestral homes to take possession of new territory. Likewise military strength and survival have been at times roughly proportional to numbers. Industrial and commercial prestige is also roughly proportional to population among nations of approximately the same stage of economic development. Differential decline in birth-rates therefore tends to upset the comparative standing of races and nations. Moreover and most significant of all, a checked birth-rate reduces the operation of natural selection and thus tends to interfere with the process by which man increased in physical strength and intelligence.

More than a century ago Malthus declared that there was a tendency for population to increase faster than the means of subsistence. Observing the great mass of poverty and degradation in contemporary England, he was led to the belief that numbers of a population must be kept within bounds by famine, pestilence, poverty, vice, crime, and war. Malthus pointed out that the only way to obviate the operation of these positive checks was the introduction of the negative check upon population increase. By this he meant moral restraint, including thereunder both postponement of marriage and continence within the marriage relation. A century's experience has shown that food supply and the conveniences and comforts of life can be multiplied by man's inventive and industrial capacities more rapidly than the population increases. Doubtless no period in the world's history has shown an equal increase in numbers of the white or civilized races. Nevertheless the white world's supply of consumable goods has increased several fold per capita. We are, therefore, today under the necessity of considerably modifying the Malthusian formula. There is, experience shows, no inevitable and fatalistic tendency among advanced nations for population to increase beyond bounds; but there is in every social rank a consciousness of the conflict between reproductive forces and the desires for wealth, education, recreation, leisure, social position, foreign travel, and other features of an advancing standard of living.

PRESSURE IS INTENSIFIED.

It is now well established that the pressure of population which Malthus laid so much stress upon is not a pressure upon the means of subsistence, but rather upon the standards of living. Moreover recent experience would seem to indicate that this pressure is intensified rather than reduced by an increase in wealth, so that the size of the family tends to diminish as one ascends the social scale. Malthus's error therefore was in the supposition that population would forever tend to expand with its material basis. At the very time when the thinking people of Western Europe were thrown into a most profound pessimism by his treatise, there was

beginning in France and America an actual decline in the birth-rate. This decline did not become pronounced in Western Europe until the decade 1870 to 1880. It is more than a coincidence that at this same period Mrs. Annie Besant and her confrères in Theosophy began openly to advocate New-Malthusianism. They contended that the number of children in a family should be consciously limited. To this extent they agreed with the moral restraint doctrine of Malthus; but they did not advocate the postponement of marriage, but rather interference with the normal processes of reproduction. Since the late seventies the entire Western world has silently acquiesced in this doctrine, so that we find today that contrary to the expectation of Malthus, our world is no longer in the mysterious and inexorable grasp of nature's demand to increase, but rather man is achieving control of his own perpetuation. This control is spreading to all ranks of the population so that for the first time in history the conflict of a democratic demand for high standards of living with the forces of sex and race responsibility threatens the perpetuation of entire nations. Man's expanding knowledge gives him the true freedom which comes from a conscientious and intelligent control of his environment and his own destiny, but of all his achievements none is so momentous for the future as the control over the forces of his own generation.

HERBERT SPENCER'S THEORY.

Another very interesting historical theory of population is that set forth by Herbert Spencer in the early fifties. The main thesis which Spencer sought to demonstrate is that there is a direct and unalterable opposition between individuation or individual development and genesis. His fundamental contention was that the surplus energy of an organism has two possible uses—individual growth or activity and multiplication. He showed that as animals grow in size, and above all as their nervous systems become larger and more complex the number of their offspring becomes smaller. As the individual of a species becomes highly developed and therefore able to compete more successfully with its natural enemies, the balance of nature requires that the offspring shall diminish in number. A codfish, countless numbers of whose eggs and young will be eaten, must spawn a million eggs to produce one mature descendant, but not so with the shark, the elephant, or man. Now, without going further into Spencer's reasoning, we may see here a fundamental principle to guide us in considering the problem before us.

In the earlier stages of social evolution the possibilities of individual development were narrowly restricted by the necessities of racial subsistence and perpetuation. But as man achieved a larger and larger control over nature, as he acquired knowledge and material goods, the importance of the individual increased, until in modern societies the perfection of the individual personality has come to be the chief end of social endeavor. It is among those peoples and classes where the number of offspring is greatest that individual development is lowest. On the other hand progress in knowledge and the spread of the fruits of civilization to the lower class is everywhere accompanied by a decrease in the size of the family and an increase in individual development. But if the forces of individuation, that is the opportunities and desires for personal achievement and enjoyment, outrun the forces of genesis, that is the obligations to the race, civilization will defeat itself by producing race suicide.

There is still another generalization from Spencer of special interest in this connection. He laid down as the final criteria by which one may judge the stage of evolution of the family the following principles: the first end of the family is perpetuation of the species; the second is the welfare of the offspring; and the third the welfare of the parents. That form of family is best which fulfills in due proportion all three purposes. He therefore drew the conclusion that that form of family is highest in which the period preceding reproduction is lengthened; in which the number of offspring is reduced to the minimum consonant with the perpetuation of the species; in which the lives of parents are

least subordinated to the rearing of offspring; in which the period following the cessation of reproduction is the longest possible; and in which finally the offspring themselves find pleasure in caring for parents in their old age.

PRINCIPLES ARE APPLIED.

These principles are in harmony with the progress of the family in recent times. There is a tendency among the upper classes to postpone marriage; the number of children is smaller, but not so small as yet, except in France, as to endanger the life of the race; a larger proportion of them are reared to maturity, they receive much greater individual attention, are better educated and given a better start in life; parents live longer and have a larger proportion of their lives freed from the care of children than formerly; and finally aged parents are more solicitously safeguarded than ever before. Here again we find that a decline in the birth-rate is in harmony with a higher type of family. But here also we must note that there is a conflict between some ends and others. The fundamental purpose of the family as a social institution is the perpetuation of the species; it is this which makes the family so profoundly important; it is this which accounts for the extraordinary care with which society at all stages has safeguarded it by numerous restrictions and requirements. When therefore the pleasure-seeking of parents, or their welfare in any other regard, which is the third purpose of the family, comes to dominate the racial responsibility which is its first purpose, then it is no longer in harmony with the conditions which a permanent society is bound to enforce.

Space does not permit a statement of the extent of the decline in the birth-rate. It is generally known that every Western nation is experiencing a decrease in its birth-rate. It is also a matter of common knowledge that this phenomenon is disturbing the balance of power and raising questions of the greatest political and military significance.

When it comes to the causes of this decline there is less unanimity. This is one of the subjects in the explanation of which causes stated often prove merely a presentation of the personal biases of their propounders. Only the more important can be noted here.

It is commonly thought that an important factor in the decline of the birth-rate is the postponement of marriage. The statisticians of a decade or more ago were accustomed to show a close correlation between the marriage rate and the birth-rate. The marriage rate varied either directly or indirectly as did economic conditions, and the births followed a similar course a year or two later. But now this connection is being seriously disturbed. In France there has been a very slight decrease in the proportion of persons under 20 who are married; but this has been more than offset by an increase in the proportion of those of ages 20 to 30 who are married. Indeed in Europe generally the proportion of persons under 30 who are married is increasing except in England and Scotland. Moreover on the whole marriages take place earlier in France than in England, Germany, or America. Nor is this all, for a larger proportion of the French population is married than in any of these other countries. Thus the birth-rate in France has continued to fall in spite of those very conditions which should have sustained it or even caused it to increase.

IN THE UNITED STATES.

In the United States, contrary to popular opinion, marriages are not only more numerous but are contracted at earlier ages than they were 20 to 25 years ago. Thus when comparison is made of the censuses of 1890, 1900, and 1910, it is found that the proportion of the population classed as single has steadily diminished and the proportion of married has steadily increased. Moreover this is true of both sexes. When a study is made of conjugal condition by all classes one is astonished to find that a larger proportion of young men of age groups 15-19, 20-24, and 25-34 were married in 1910 than in 1890 or 1900; and that a larger proportion of young women of ages 15-19 and 20-24 were married in 1910 than formerly. One is therefore forced to the conclusion that if we view the population of the United States as a whole marriage is

neither avoided nor postponed as compared with a decade or two ago, but that on the contrary it is more general than heretofore and is undertaken at earlier ages.

If now we carry our inquiry a little farther we meet with other surprises. The census classifies the population under four headings, Native White of Native Parentage, Native White ot Foreign or Mixed Parentage, Foreign-Born White, and Negro. The returns show that in every one of these four groups there was a larger proportion of married among both sexes in 1910 than in 1890, except among Foreign-Born Whites where the proportion was practically the same (62.2 in 1890 and 62.1 in 1910). Moreover when age groups are studied, one finds that the proportion of married is greater in 1910 than in 1900 or 1890 in all four nativity classes for both males and females of ages 15-19 and 20-24; and that this is also true for both sexes and all four classes in the age group 25-34, except among foreign-born males where the proportion in 1910, though larger than in 1890, was slightly smaller than in 1900.

We are forced therefore to conclude that in all nativity classes of the population as in the population as a whole there is a tendency for the proportion of persons married to increase and a tendency for marriages to be undertaken at an earlier age. This is a very unexpected result with respect to the native whites of native parentage. This class includes those whose parents were born in this country; it is to this class that the professional and propertied familes belong and it is frequently asserted that this class is avoiding marriage to an extent that shows a decline in their sense of social responsibility. While it is true that marriage is later in this class than among artisans and unskilled laborers, and while in certain strata of this class the age of marriage is doubtless later than formerly, nevertheless taken as a whole it is undertaking marriage as readily as, and even more readily than, in past decades.

Numerous other causes have been brought forward by the French students of this phenomenon. The style of women's dress; over-eating, especially consumption of meats; over-refinement; salacious literature, the theatre andother excitants of morbid cravings are believed by some to be causes. Then much stress is laid upon physiological sterility; but statistical evidence seems to minimize its significance. Doubtless considerable importance must be attributed to venereal infections.

CAUSE IS PSYCHOLOGICAL.

But magnify as we may all other causes of the decline, the fact remains that the one conspicuous factor is the changed psychological attitude toward the size of the family. This change in attitude has a great variety of causes. In the first place the very possibility of escaping the normal consequences of natural instincts in this regard would prompt general adoption of the means thereto. Have not various inquiries shown, and is it not self-evident fact, that women have in the past been held in the iron grasp of an inexorable fate which has imposed upon them in a large proportion of cases the complete sacrifice of themselves to a monotonous round of drudgery and child bearing? The increasing freedom of woman, the growing power and importance of her personality, the inevitable demand on her part to be recognized as an equal in the responsibilities and the honors of racial achievement; all these have reacted upon the size of the family. There has in addition been a great decline in religious control; the most Catholic department in France has had in recent years an excess of births over deaths seven times as great in proportion as the rest of the country.

Then there is the imitation of the rich by the poor, of the social élite by all others. It has been and still is true that the big families live in the little houses and the little families in the big houses; but more and more generally it is becoming true that the children who grow up in the little houses are demanding the education, the training, the leisure, the social opportunities of those who grow up in the big houses, and their parents are ambitious to give them every possible advantage. Here indeed is the great central fact,—individual ambition.

Here is Spencer's principle of the tendency of progress to magnify and exalt the individual personality; here also is his principle that social advance is accompanied by a decreasing sacrifice of parents to racial demands.

Now this of course has its good and its bad features. There may be individual ambition which takes the direction of pure sordidness—the excessive selfishness of the woman who will not surrender a part of her inconsequential and socially valueless card playing and dancing or of the man who doesn't want to share any of his income or his property and the freedom they give him. Now it is equally true that neither matrimonial concubinage nor brutal, soul-destroying selfishness are socially justifiable. Individual ambition may on the other hand take the direction of social achievement. It is undoubtedly true that children are an impediment to the man or woman who would win fame in business, science, literature or art. But here what society loses in talented offspring is in part counterbalanced by greater present achievement. Individual ambition may and now frequently does take the direction of a desire for the better training and equipment of children for the duties of life. When, however, the combination of ambition for the child and selfishness and fear on the part of the parents results in the one-child family, it often happens that the child has lost more by the absence of brother or sister than he has gained by the increased chance of a good start in life.

PROPER SIZE OF FAMILY.

There is, I believe, nothing that promises more for the solution of problems of poverty, low wages, economic inequality and kindred social problems than the fact that parents are acquiring the power to determine in each case what their family should be, but there must be a golden mean between none and a dozen which represents the socially desirable. If three or four children for each fruitful marriage are necessary to maintain the population in a stationary state, then three, four, or five children must represent the family which society would profit by standardizing. While individuals of great genius may here and there profit by complete freedom from early struggles, it nevertheless remains true sociologically that a race which is to remain strong and progressive must develop in its youth a sense of self-reliance and a willingness to undergo hardships which cannot come when all needs from childhood to manhood are provided by the paternal pocketbook.

It is extremely difficult in practice to get the wisest proportioning of size of family and economic resources. A truly democratic system would require many children of the rich and few of the poor; this would quickly destroy class divisions. The rich, the well-to-do, the professional classes maintain their supremacy in the social system partly because their numbers are small and unskilled laborers do the meanest work at the lowest wages because their numbers are large. But a more ideal social arrangement will be that in which the number of children is so related to the economic status of the family that individual ambition will not be killed by the enervating effects of luxury on the one hand or the demoralizing effects of poverty on the other. Such an arrangement would permit most rather than the favored few to share the fruits of civilization, would so enlarge the opportunities of the lower classes that society would get the benefit of much talent at present smothered by the grime and toil of economic insecurity.

There are those conspicuous in the councils of the nation who urge upon all the public duty and the personal joys of large families. But there is reason to suppose that the unfit are now multiplying more rapidly than the fit. And in the second place the chief fault with modern society is that it has too many poor, too many at the bottom already. What we ought to work toward as a public policy is the reduction of the great mass of unskilled labor and the consequent equalization of economic opportunities. Of course there are different ideals of what society ought to be. Some prefer great masses of people, large volumes of imports and exports, great armies and the pomp and noise of a world power; and they prefer these things even though they be purchased

at the expense of great inequalities, much poverty, and a low standard of public life. Others prefer a greater equalization of wealth, a juster distribution of life's opportunities, increase in the general intelligence, and achievement in civilization rather than in money making. We hear of many philanthropic measures to better the condition of the poor, but there is no proposal which will be so efficacious in the elevation of their status as the reduction of their numbers. The propaganda now being carried on by the Neo-Mathusians and the Socialists among working people, whatever may be its other social consequences, will raise the economic and social status of those whom every true democrat devoutly wishes to share in the best that life affords.

A DIFFERENTIAL DECLINE.

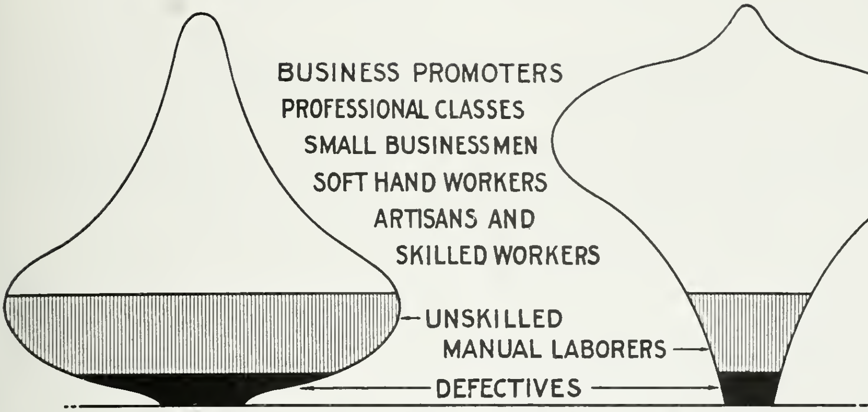
Another important feature of this whole problem is the probability that the decline in the birth-rate has affected the better stocks more generally than the poorer, with the result that Western nations are now reproducing themselves mainly from the less able. This would gradually shut off the supply of talented men, of geniuses, of men who invent, discover, and create, of men who set new standards and lead to the performance of new duties. This would be to add to race suicide the evils of racial decay and degeneration. By the lavish provision of homes, asylums, and charitable agencies of all sorts we make it easy for the lazy, the shiftless, the immoral, and the defective to multiply apace; and by the growth of sanitary and medical science we are preserving a larger and larger proportion of those whom nature would pronounce unfit.

When it comes to a comparison of the different economic classes there are those who hold that differences in rank are due entirely to differences of ability; then there are those who hold that natural abilities are about equally distributed among all classes. It is frequently argued that the one great misfortune of the poor is their poverty and that accident and good luck have played a leading rôle in the elevation of those who happen to be at the top. Undoubtedly there is much truth in this; social arrangements are not just; opportunities are far from equal. But in a land where opportunities have been large and moderately well distributed, achievement becomes in a rough way an index of ability, and failure for several generations marks a family as of mediocre blood. In any case the probability that talent is altogether as frequent among the lower classes as among the upper would seem to be small. The social problem with reference to the masses, even though they should be equally talented with the classes, is to so reduce their numbers and enlarge their opportunities that the inherent talent they do possess may become socially creative. At the other end of the social scale the problem is to secure a perpetuation and increase of those with natural ability.

But the statistics of college graduates indicate that a smaller proportion of them marry than some decades ago, that the age at which they marry is later, and that the number of children has fallen steadily and sharply. It surely cannot be argued that there is no social loss when families who have achieved education and economic freedom fail to maintain their places in the social composition.

On the other hand numerous studies by Eugenics Laboratory and University of London students, by Rowntree, Charles Booth, and others in America and Europe show that the lower the wages, and therefore the natural ability, the larger the family. As one ascends in the economic scale the size of the family diminishes. However much one may be impressed with the obvious inequalities of modern social arrangements and the undoubted exploitation of those rendered helpless by poverty the evidence of such facts as just cited forces the conviction that there is a tendency for advanced nations to die at the top and to be replenished too abundantly from their less able stocks.

Unless we can somehow find a way to make income proportional to inherent ability and the size of the family roughly proportional to income our civilization will neither meet the requirements of social justice nor the essential conditions of its own permanency. Just how this



WHAT A EUGENIC REFORM WOULD MEAN

The accompanying charts show respectively the distribution of economic classes in present society (at the left) and the distribution that would result were size of family to be roughly proportional to income and native ability; were also negative eugenics to be used to prevent the multiplication of the defective; and were the educational opportunities of the industrial classes greatly increased (at the right). These charts are merely suggestive: proportions and class designations are not exact. (Fig. 18.)

is to be done is another matter. Rome's efforts to preserve her best blood by legal requirements failed. Recent French proposals include the education at public expense of every seventh child in a family; the taxation of bachelors and the exemption or abatement of taxes of fathers of large families; additional votes to fathers in proportion to the size of their families; a public bounty of 500 francs for the third and every additional child. All these and numerous other proposals lack an essential quality—they are indiscriminate and uneugenic. They would probably have the sole effect of increasing the proportion of the inefficient; they might increase numbers but they would hasten degeneration.

There are those who believe that the decline in the birth-rate cannot be checked; and it does seem that civilization tends to commit suicide by freeing the individual and enabling him to flout the race. Is it possible that a race can be kept alive only by maintaining a substratum of poverty-stricken, brute-like creatures upon whom must rest not only the weight of ceaseless toil, but the burden of renewing the ever-disappearing cultured but enervated social favorites? Can we destroy poverty, and with it the grosser injustices of our crude anarchistic social system, elevate the whole mass of the nation to sharers in the fruits of civilization and at the same time not bring self-destruction to our white blood but rather raise its quality above the best the world has yet seen? If we still wish to be optimistic we may reflect that ours is perhaps a period of transition; that man's new knowledge must ever give him added responsibility as well as increased liberty; and that there is much hope for both a finer social order and a higher type of man in the education of coming generations in what is eugenically fit and in the social responsibilities required by an altogether new and momentous power.

Need of Family Histories

The investigation of human eugenics—that is, of the conditions under which men of a high type are produced—is at present extremely hampered by want of full family histories, both medical and general, extending over three or four generations. Believing, as I do, that human eugenics will become recognized before long as a study of the highest practical importance, it seems to me that no time ought to be lost in encouraging and directing a habit of compiling personal and family histories.—Francis Galton: Inquiries into Human Faculty (1907).

INBREEDING IN DOGS

Statistical Study of the Pedigrees of Two Typical Breeds—Inbreeding Not so Commonly Practiced by Dog Fanciers as Popularly Supposed and Not so Productive of Results as Line-Breeding.

WILLIAMS HAYNES, *New York, N. Y.*

THAT the thoroughbred dog is very closely inbred is the belief shared alike by the general public and breeders of other kinds of stock. Upon this belief are based most of the objections raised against the thoroughbred either as a companion or a hunting dog. Among dog fanciers, one hears both extravagant praise and bitter denunciation of inbreeding.

In certain studies I have recently carried on in terrier breeding I was collecting some data from the stud book records, and I determined at the same time to discover, if possible, what proportion of registered dogs are inbred and whether or not these inbred dogs had been markedly successful in bench show competitions. The results are surprising and furnish some interesting conclusions on the comparative value of in- and line-breeding.

For this analysis I selected two breeds, the Airedale and Scottish terriers. Both belong to the same general family: both are popular: both have known histories and carefully compiled records. But each has a very distinct origin, and neither is in any way related in blood. The Scottish terrier[1] came from the Highlands where they have been known as a distinct breed since the Sixteenth Century. They are the oldest breed of terriers that have been preserved in anything like their original form. The Airedale terrier,[2] on the other hand, is a manufactured breed which originated in Yorkshire something over fifty years ago.

Selecting at random, but picking half from each sex and 10 from each volume of the stud book for the past 10 years, in 100 Scottish terriers we find three inbred dogs, one from a sire bred to his own daughter, one from a dam bred to her son, and one from full brother and sister. Selecting 100 Airedale terrier pedigrees in the same manner, we find seven examples of inbreeding, six from a sire bred to his daughter and one from a full brother and sister. In other words in the pedigrees examined, 3% of the Scottish terriers and 7% of the Airedales are inbred.

BREEDING CHAMPIONS.

The avowed object of breeders of these dogs is to produce a dog that shall win at the bench shows. The highest honor a dog can receive is the right to the title of Champion, which means that it has won a certain number of first prizes under at least three different judges. The rules differ somewhat in detail in England and this country, but the underlying principle is the same. While there are undoubtedly dogs that in fancier's phraseology are known as "lucky champions," still it is safe to say that dogs winning the title are above the average quality of their breed, closer to the ideal as expressed in the standard. Moreover since to breed champions is the object of the fancier's breeding operations, the per centum of

[1]Davies, C. J., The Scottish Terrier, London, 1907.
McCandlish, W. L., The Scottish Terrier, Manchester, Eng., 1909.
Haynes, Williams, Scottish and Irish Terriers, New York, 1912.
[2]Buckley, Holland; The Airedale Terrier, Manchester, Eng., 1907.
Haynes, Williams, The Airedale, New York, 1911.
Jowett, F. M., The Airedale Terrier, London, 1912.
Palmer, R. M., All About Airedales, Seattle, 1912.

	Average dogs.	Champions.
SCOTTISH TERRIERS		
Inbred	3	1
Line-bred	4	9
Out-bred	93	90
AIREDALE TERRIERS		
Inbred	7	2
Line-bred	6	10
Out-bred	87	88

NOTE.—The "Line-bred" in the above only includes dogs bred from the primary cross of half brother to half sister, and there are certainly dogs in the "Out-bred" that are truly in-bred.

inbred dogs winning championships furnishes a gauge to judge the effectiveness of this breeding system in accomplishing the result desired by the breeders of these animals.

Of 100 Scottish terrier champions, one is inbred, from a dog mated to his own daughter. Of 100 Airedale champions, two are inbred, one from a bitch mated to her own son and one from full brother and sister.

LINE BREEDING.

In the case of line-breeding, however, we get very different figures. Taking only the two primary crosses of line-breeding, *i. e.*, the crossing of half brother and sister, sired by the same dog, and half brother and sister, dammed by the same bitch, which, of course, does not begin to include all line-bred dogs, we find that of the hundred Scottish terriers picked at random four are line-bred, all from half brother and sister with the same sire. Of the hundred average Airedales six are line-bred, five from half brother and sister with the same sire, and one from half brother and sister with the same dam. Among the hundred Scottish terrier champions nine were bred this way, eight from half brother and sister with the same sire and one from half brother and sister with the same dam; and 10 Airedales champions were so bred, nine from half brother and sister with the same sire and one from half brother and sister with the same dam.

It will be immediately noted in the above table that in- and line-breeding are more common in Airedales than in Scottish terriers, the ratio being close to two to one in all cases. Possibly this may be accounted for by the fact that being a manufactured variety, close breeding has been more or less forced because of lack of breeding stock. It will also be noted that the close breeding popularly supposed to be practiced by dog fanciers is not apparent. In the cases of the average dogs, only 7% of the Scottish terriers and 14% of the Airedales are closely bred.

The salient feature of these figures for the breeder is, of course, the evidence they present that line-breeding has, in the cases of these two breeds at least, proved very much more effective than in-breeding in accomplishing the object desired. The ratios of champions produced in Scottish terriers is 1 to 9, and in Airedales, 1 to 5. These figures confirm my studies in prepotency in Airedales.[3]

Summarizing the data, it is evident that neither inbreeding nor close line-breeding is used as much by dog breeders as is generally supposed, and that of the two systems line-breeding has been the more productive of results.

[3]Science, N. S. XXXVII, No. 977, pp. 404-405.

Mendelism in Man

Such rules (those of Mendelian heredity) have been demonstrated in operation for an immense diversity of characteristics in both animals and plants in great variety. It should be explicitly stated, however, that in the case of the ordinary attributes of normal men we have as yet unimpeachable evidence of the manifestation of this system of descent for one set of characters only, namely the color of the eyes.—William Bateson: Biological Fact and the Structure of Society (1912).

PIONEERS IN EUGENICS

Institute of Heredity Organized a Generation Ago, but Died Because Ahead of its Time—Object of Promoters to Advance Race Betterment by Study of Causes of Deterioration, by Better Breeding, and by Segregation of Defectives.

A. E. Hamilton,

Extension Department, Eugenics Record Office, Cold Spring Harbor, Long Island, New York.

BROWSING among the books in the library of the Eugenics Record Office, I happened on a quaint little brown covered volume stamped in gold with the one word *Heredity.*[1] I glanced it through and, charmed by its naive enthusiasm, sat down and read it with as much interest as though it had just come in hot from the griddle of a contemporary geneticist. It proved to be the correspondence between Elizabeth Thompson and Loring Moody, published in 1882 by The Institute of Heredity, in Boston. As the booklet has long been out of print and is probably a rare specimen of early eugenic literature, perhaps a few fragments from its pages would not be out of place in the light of day again.

"Having from early manhood," it begins, "been actively and earnestly engaged in various humane labors for the improvement and welfare of our race; having set on foot and organized several reformatory and benevolent movements; and having been a close observer of the practical workings and effects of these during nearly half a century; and from these having been led to a larger survey of the field, including all of our public and private charitable, benevolent and corrective institutions,—the conclusion is unavoidable that all of these institutions are at best only temporary expedients, for, while they afford some relief and a few instances of reform, they leave the roots and sources of evil untouched by their operations.

"This conclusion only led to another, viz., that in order to make any successful warfare against social disorders we must advance directly upon their strongholds, and dry up the fountains from which they spring. So I drew up the following circular, which with the aid of judicious friends—among them were Henry W. Longfellow, Samuel E. Sewall, and Mrs. Horace Mann—was printed and sent widely over the country—to the editors of several publications among others."

The circular stated what Mr. Moody considered the higher demands of humanity and announced his problem as being that of setting in motion such prenatal influences as should make the hereditary tendencies of future generations wholly good. "The generative power must be educated, trained and guided by the highest wisdom and scientific culture, as the only sure foundation of effective and permanent reform."

NO ADVANCE THROUGH PUNISHMENT.

"And for the reason that we have battled against effects," he continues, "while leaving causes in unchecked operation," have our reformative results been hopeless and unsatisfactory. "The causes are congenital. People who are born with theft and murder in the blood will steal and kill. The jailor and hangman neither cure them, nor check their

[1]Moody, Loring & Thompson, Elizabeth; Heredity: Its Relation to Human Development: Boston, 1882, Institute of Heredity, 159 pp.

tendencies, nor thin their ranks. For, as fast as we imprison and hang criminals others are born to take their places; so that all our conflicts with evil result in long-drawn battle."

"The true way of regenerating the race is through scientific generation. The demand of the time is, that we lay the right foundations of character by fixing the organic tendencies of children, in moral and physical health, before birth."

Mr. Moody evidently appreciated the need for that organization of knowledge which should give mankind the generalizations upon which it might work out this eugenic ideal and he earnestly hoped that persons of the highest wisdom, courage and devotion to public duty might come forward ready for this work, and take the first steps towards the formation of an *Institute of Heredity*, "which shall found a library, establish lectureships, with schools of instruction, and take in hand the diffusion of knowledge on the subject of improving our race by the laws of physiology."

The time was hardly ripe, when Mr. Moody wrote, for the founding of such an institution as he dreamed of, where "such conversations, consultations, and illustrated lectures as may awaken interest and lead on towards a realization of these great and beneficent ends" might be held. The school and lecture room in Boston, which he planned, together with its library which he hoped would grow into a research center, were not supported as he thought they might be and the first attempt at organization for eugenic investigation and research in America melted away.

Of the movement he says—and a considerable number of our newspapers and magazines have confirmed his prophesy—"It will encounter misunderstanding, opposition, and even ridicule and reproach, from ignorance, prejudice and bigotry. It must be sustained by the highest wisdom, prudence and forbearance. Hence it will need the sympathy and coöperation of every enlightened philanthropist and reformer."

FINDS ONE ADHERENT.

One such enlightened philanthropist and reformer, at least, responded to Mr. Moody's circular. In the little booklet, which seemed strangely lonely and out of place among the ranks of scientific memoirs and fat genealogies, are gathered some of the letters written back and forth between Mr. Moody and Mrs. Elizabeth Thompson who realized that she had been giving "much time, labor and money in aid of numerous schemes to palliate the evils of society, while leaving the causes of these evils to continue their destructive work."

"If I understand you rightly," she wrote, "You propose to carry a searching investigation into the causes of all the moral, mental and physical disorders of society, for the purpose of awakening a public demand for their removal. Will you please give me your opinions more fully as to the causes of these manifold disorders, and the conditions under which they are developed and transmitted from parent to child?"

Mr. Moody was not deceived by his ambition and ideal, he did not take the wish for the fact, he felt his lack of knowledge and in answering his enquirer he made the same reply as the conscientious student of eugenics would today—

"A glance at the roll of premature deaths, the ravages of disease, the records of our criminal courts, the tenants of our jails, houses of correction, reform schools, asylums for lunatics, idiots, inebriates; the abortions, infanticides, and other disorders and evils too numerous to mention,—will satisfy any thoughtful, reflective mind that the reproductive forces of the human race are terribly clogged and out of gear, and that the time has fully come for us to accumulate a groundwork of knowledge upon which we can move forward in the great work of delivering our race from this terrible waste, suffering and ruin."

NEGATIVE EUGENICS.

He also realized that, while more knowledge is of paramount importance to any attempt at racial improvement, there are some things that should be done immediately, and he outlined his plan of "negative eugenics" in a later letter.

"Then," he writes, "As a means of eliminating the inherited effects of disorders from posterity, I would have

the government establish and maintain good, comfortable, attractive hospital homes for the care, treatment and life residence of all habitual drunkards, confirmed criminals, idiots and incurable lunatics, who should be treated as people suffering from dangerous congenital diseases liable to propagate through heredity; and so they should be strictly guarded from having any offspring, as far as possible by moral, and the remainder by legal, restraint . . . These homes should be established in different localities, classified and arranged to meet the requirements of the patients afflicted with different disorders. Should we hesitate in view of supporting so many people in these homes, let us remember that their numbers would be constantly decreasing by natural causes, and as the wiser and better generation, which we shall in the meantime establish, will so cut off the supply that in a few generations there will hardly be any left; while by the present modes of treatment drunkards and criminals will be arrested, convicted and sent to prison over and over again for repeating their offences."

Then followed letter after letter brimming with facts drawn from observation and from the works of such scholars as Galton, Sharpe, Anthon, Ribot, Papillon and others like-minded in their views of national deterioration. Mrs. Thompson aided the work Mr. Moody had undertaken with her influence and with money so that some seed was sown, as witnesses the little book, but the dream of an Institute of Heredity was not realized until after Mr. Moody's death. One cannot but wish that the ghosts of such early pioneers could wander through the roomy buildings where records of inheritance are slowly accumulating day by day, and browse among the books of the library that has been started, and where their works may some day all be found, even as I chanced on this brown booklet today.

The Possibility of Eugenics

The improvement of our stock seems to me one of the highest objects that we can reasonably attempt. We are ignorant of the ultimate destinies of humanity, but feel perfectly sure that it is as noble a work to raise its level in the sense already explained, as it would be disgraceful to abase it. I see no impossibility in eugenics becoming a religious dogma among mankind, but its details must first be worked out zealously in the study. Over-zeal leading to hasty action would do harm, by holding out expectations of a near golden age, which will certainly be falsified and cause the science to be discredited. The first and main point is to secure the general intellectual acceptance of eugenics as a hopeful and most important study. Then let its principles work into the heart of the nation, who will gradually give practical effect to them in ways that we may not wholly foresee.—Francis Galton: Essays in Eugenics (1909).

Negative Eugenics

Having already defined positive eugenics as the encouragement of parenthood on the part of the worthy, we may define negative eugenics as the discouragement of parenthood on the part of the unworthy. It must be remembered that we shall not raise or regenerate the race merely by purging it of diseased elements, however necessary and desirable that process may be. Eugenists must beware of supposing that they have done any more than a preliminary piece of work, prior to a fair start, when they have achieved, say, the segregation of the feeble-minded.—C. W. Saleeby: The Methods of Race Regeneration (1911).

RECENT BOOKS ON HUMAN HEREDITY

AMEY EATON WATSON, *New York, N. Y.*

Schuster, Edgar—Eugenics; a Science and an Ideal. The Nation's Library. London. Collins, 1913. Price 1s.; pp. 264.

Attempts to give an account of the meaning of the word eugenics, the aims of those who advocate an eugenic policy and the more important of the problems which confront them. Endeavors to indicate, not only the conclusions arrived at by those best capable of judging but also the arguments on which their opinions have been based.

Von Hoffman, Geza—Die Rassenhygiene in den Vereinigten Staaten von Nordamerika. Munich. J. F. Lehmann, 1913. pp. XXI and 237.

Of great service to all who wish to make a serious study of eugenics, especially of Negative or Restrictive Eugenics. The author has been Austrian Vice-Consul in California and has spent several years in making a thorough study of these subjects. Concludes with a descriptive bibliography.

Reed, Charles A. L.—Marriage and Genetics: Laws of Human Breeding and Applied Eugenics. Galton Press, Cincinnati, 1913. pp. 183.

This book, from the pen of a surgeon, was written with a desire in some measure to overcome the ignorance which keeps people from protecting themselves and their offspring from disease and degeneracy. The foundation of its thesis purports to be the natural laws of human breeding inherent in the individual. While based largely on Dr. Davenport's "Heredity in Relation to Eugenics," this book is by no means so careful or scientific in its treatment.

Roper, A. J.—Ancient Eugenics. Oxford, Blackwell, 1913. Arnold Prize Essay for 1913.

Mainly historical, surveying the progress and practice of eugenic ideals from the time of barbarism in Sparta, Germany, Athens, etc. Quoting from the authorities of the times. Plato, Aristotle, Caesar.

Wormald, John and Wormald, Samuel. Guide to the mental deficiency act, 1913. London. P. S King & Son, 1913. pp. 145.

Reviewed in the Eugenics Review, April, 1914. We are told that authors are physicians, having special qualifications for their task. Sections deal with (1) operation of the Act, (2) authorities under the Act, (3) administration of the Act, (4) offences against the mentally defective, (5) finance and statistics, (6) conclusions.

White, W. A and Jelliffe, Smith Ely, Editors. The modern treatment of Nervous and Mental Diseases. Lea and Febiger, 2 volumes, 867 and 900 pp. respectively. Price $6.00 each.

The contributors to these two volumes include many of the best men in America and England; Havelock Ellis, Ernest Jones, Gordon Holmes, and S. A. R. Wilson. Of especial interest are the chapters on eugenics and heredity, alcoholism, and syphilis.

Thorndike, Edward L.—Educational Psychology, Vol. III, Mental Work and Fatigue and Individual Differences and Their Cause. Teachers' College, Columbia University, 1914. pp. X and 400. Price $2.12.

Chapter XI deals with the Influence of Immediate Ancestry or Family, summarizing many of the more important studies in human heredity that have recently been made and criticises them from the standpoint of modern psychology. A valuable discussion of Mendelian inheritance.

Saleeby, C. W.—The Progress of Eugenics. Funk and Wagnalls Co.

A new book by the English Eugenist promised for the late spring.

THE BARE NECKS

Some three years ago we purchased of a neighbor who had brought back with him from the Barbadoes two cocks and three hens characterized by the absence of feathers from the neck as far as from the ears down to the clavicle. In most of the hens there was a paired bunch of feathers on the ventral side of the neck; but one was practically free from feathers in that region and this condition has reappeared in her offspring. These birds are very sparsely feathered under the wings and over the sternum also

The thing that interested me most was the hereditary behavior of this condition. Mated to each other these birds gave a few full-feathered chicks, but about three-fourths of all were bare-necked. Mated to ordinary fowl, about half of the offspring had naked necks—there was very little indication of imperfection of dominance. It appears, consequently, that the naked neck is a typical dominant and in accordance with current interpretations, one may say that there is a factor in the "Bare Necks" which interferes with the development of the neck feathers.

Some years ago I pointed out that the condition of clean shank is dominant over that of feathered shank in poultry. In the light of the later result one may generalize and infer that the typical (primitive?) condition of the fowl is this, that every skin plate bears a feather; and that if any portion of the skin is without feathers, it is due to a specific inhibitor to the development of the feather germ in that region. Of these inhibitors there are probably a number; there are at least one for the shanks and one for the neck and possibly an additional one for the ventral patch of the neck. So far as we have gone it seems probable that the inhibitor is of the nature of an anti-enzyme which interferes in a given area with the development of those enzymes that induce the formation of the feather. (Fig. 19.)

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CONTENTS

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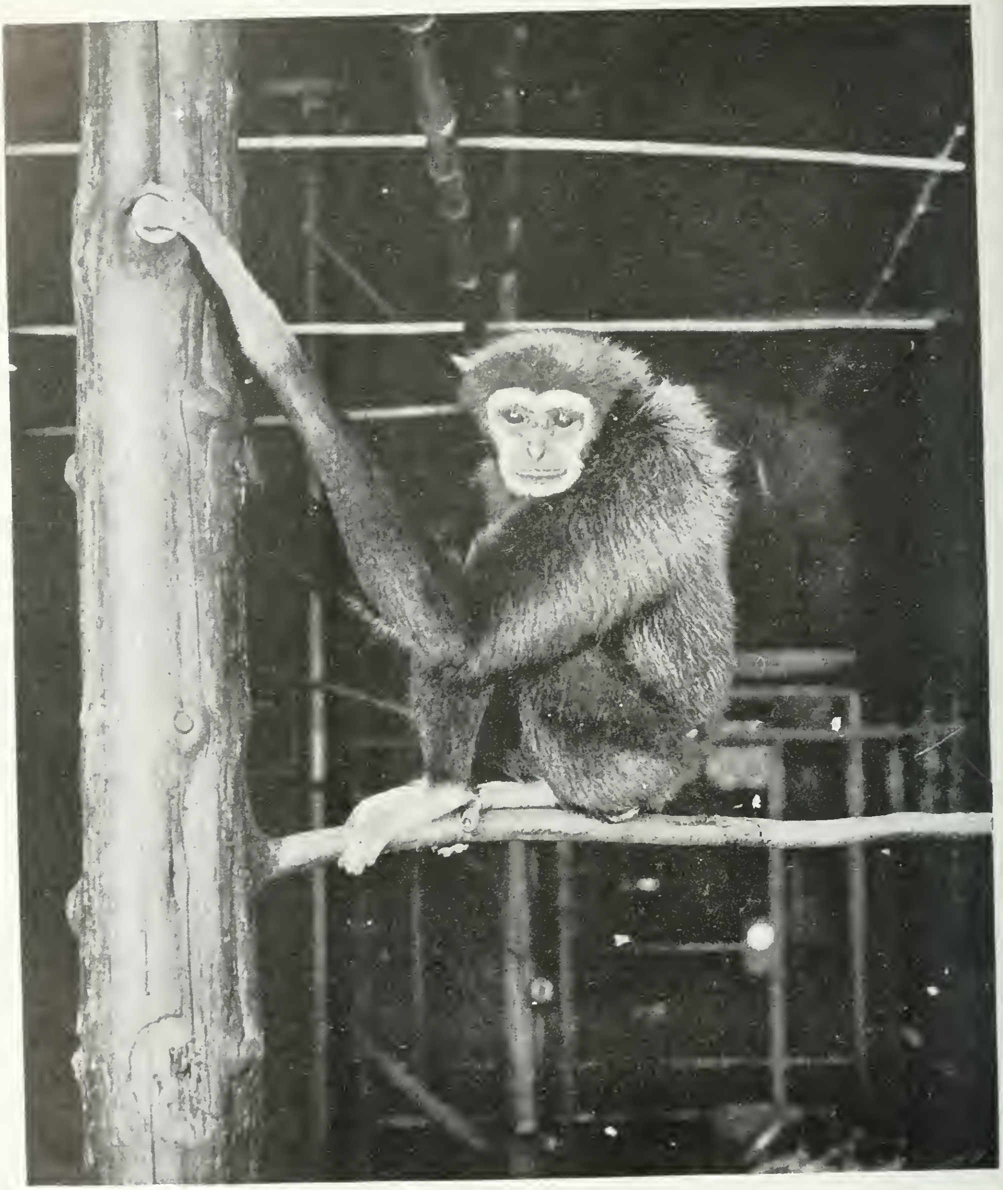


THE MOST PRIMITIVE ANTHROPOID.

White-handed Gibbon (*Hylobates lar*). The gibbon, Dr. Smith says, "is a true, if very primitive, anthropoid ape, nearly related to the common ancestor of man, the gorilla and the chimpanzee." The earliest gibbons were able to walk upright, but their brains were not sufficiently developed to enable them to make any use of this adaptation, and it is only the ancestral line of man that finally took advantage of it, with the freedom which it gave for the use of the hands. Even today the hands of the white man are more primitive in their characteristics than those of the anthropoid apes, or even than those of the negro—an indication, the writer points out, that he was not obliged to specialize them any further, after this early period, but made his evolutionary progress along other lines, principally relating to mental accomplishments. Photographed by Elwin R. Sanborn of the New York Zoological Society. (Frontispiece.)

MAN'S PEDIGREE

Line of Descent Fairly Clear as Far Back as Eocene Epoch—Development of Brain the Factor Which Separated Ancestors of Man from Other Apes—Effects of Life in the Trees.[1]

DR. G. ELLIOT SMITH,

Professor of Anatomy, University of Manchester, England.

NO ONE who is familiar with the anatomy of man and the apes can refuse to admit that no hypothesis other than that of close kinship affords a reasonable or creditable explanation of the extraordinarily exact identity of structure that obtains in most parts of the bodies of man and the gorilla. To deny the validity of this evidence of near kinship is tantamount to a confession of the utter uselessness of the facts of comparative anatomy as indications of genetic relationships, and a reversion to the obscurantism of the dark ages of biology. But if anyone still harbors an honest doubt in the face of this overwhelming testimony from mere structure, the reactions of the blood will confirm the teaching of anatomy; and the susceptibility of the anthropoid apes to the infection of human diseases, from which other apes and mammals in general are immune, should complete and clinch the proof for all who are willing to be convinced.

Nor can anyone who, with an open mind, applies similar tests to the gibbon refuse to admit that it is a true, if very primitive, anthropoid ape, nearly related to the common ancestor of man, the gorilla, and the chimpanzee. Moreover its structure reveals indubitable evidence of its derivation from some primitive Old World or catarrhine monkey akin to the ancestor of the langur, the sacred monkey of India. It is equally certain that the catarrhine apes were derived from some primitive platyrrhine ape; the other, less modified, descendants of which we recognize in the South American monkeys of the present day; and that the common ancestor of all these primates was a lemuroid nearly akin to the curious little spectral tarsier, which still haunts the forests of Borneo Java, and the neighboring islands, and awakens in the minds of the peoples of those lands a superstitious dread—a sort of instinctive horror at the sight of the ghost-like representative of their first primate ancestor.

This much of man's pedigree will, I think, be admitted by the great majority of zoologists who are familiar with the facts; but I believe we can push the line of ancestry still further back, beyond the most primitive primate into Haeckel's suborder Menotyphla which most zoologists regard as constituting two families of insectivora. I need not stop to give the evidence for this opinion, for most of the data and arguments in support of it have recently been summarized most excellently by Dr. W. K. Gregory.[2]

PRIMITIVE RELATIVES.

This group includes the oriental tree shrews and the African jumping shrews. The latter (Macroscelididae), living in the original South African home of the mammalia, present extraordinarily primitive features linking them by close bonds of affinity to the marsupials. The tree shrews (Tupaiidae), however, which range from India to Java, while

[1] Portions of presidential address delivered before Anthropological Section of British Association for the Advancement of Science at Dundee in September, 1912; printed in full in *Nature*, London, Sept. 26, 1912. Dr. Smith is not responsible for the illustrations here used.

[2] "The Orders of Mammals," Bull. Amer. Mus. Nat. Hist., Vol. 27, 1910, p. 321.

presenting very definite evidence of kinship to their humble African cousins, also display in the structure of their bodies positive evidence of relationship to the stem of the aristocratic primate phylum.

Quite apart from the striking similarities produced by identical habits and habitats, there are many structural identities in the tree shrews and lemuroids, not directly associated with such habits, which can be interpreted only as evidences of affinity.

* * * * * *

The stock from which man eventually emerged played a very humble rôle for long ages after many other mammalian orders had waxed great and strong. But the race is not always to the swift, and the lowly group of mammals which took advantage of its insignificance to develop its powers evenly and very gradually without sacrificing in narrow specialization any of its possibilities of future achievement, eventually gave birth to the dominant and most intelligent of all living creatures.

The tree shrews are small, squirrel-like animals which feed on "insects and fruit, which they usually seek in trees, but also occasionally on the ground. When feeding, they often sit on their haunches, holding the food, after the manner of squirrels, in their fore paws."[3] They are of "lively disposition and great agility."[4] These vivacious, large-brained little insectivores, linked by manifold bonds of relationship to some of the lowliest and most primitive mammals, present in the structure of their skull, teeth, and limbs undoubted evidence of kinship, remote though none the less sure, with their compatriots the Malaysian lemurs, and it is singularly fortunate for us in this inquiry that side by side there should have been preserved from the remote Eocene times, and possibly earlier still, these insectivores, which had almost become primates, and a little primitive lemuroid, the spectral tarsier, which had only just assumed the characters of the primate stock, when nature fixed their types and preserved them throughout the ages, with relatively slight change, for us to study at the present day.

Thus we are able to investigate the influence of an arboreal mode of life in stimulating the progressive development of a primitive mammal and to appreciate precisely what changes were necessary to convert the lively, agile, Ptilocercus-like ancestor of the primates into a real primate.

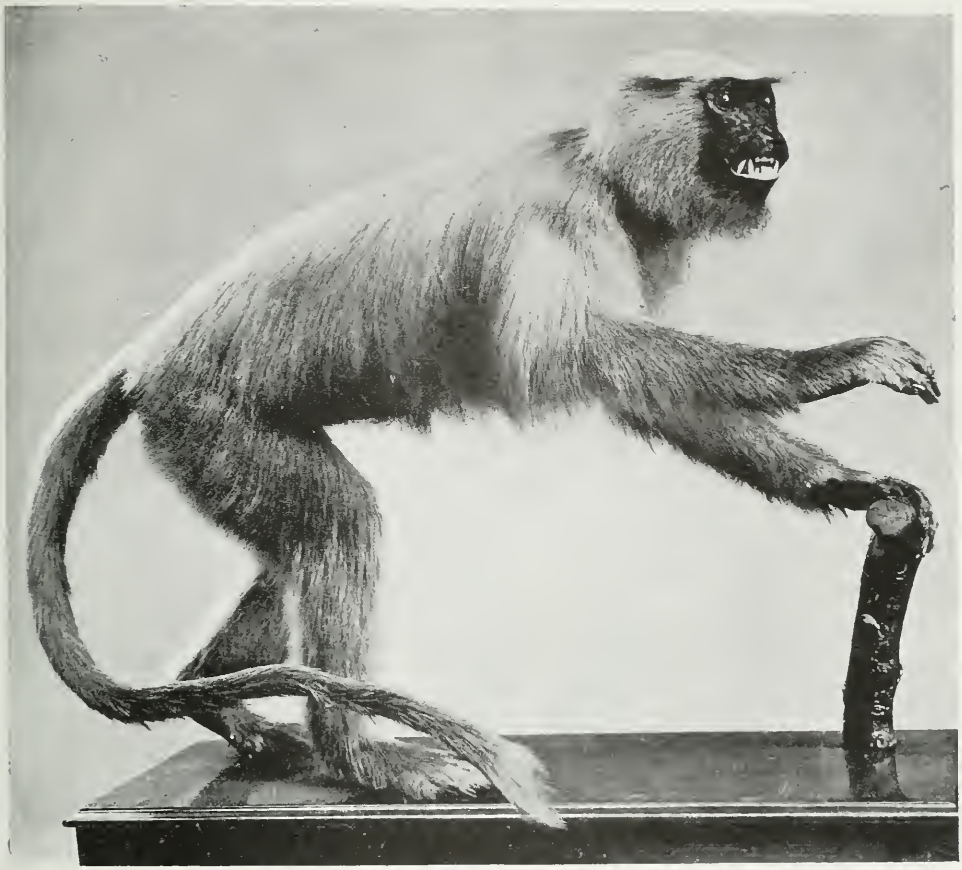
In the forerunners of the mammalia the cerebral hemisphere was predominantly olfactory in function, and even when the true mammal emerged and all the other senses received due representation in the neopallium the animal's behavior was still influenced to a much greater extent by smell impressions than by those of the other senses.

VALUE OF SENSE OF SMELL.

This was due not only to the fact that the sense of smell had already installed its instruments in and taken firm possession of the cerebral hemisphere long before the advent in this dominant part of the brain of any adequate representation of the other senses, but also, and chiefly, because to a small land-grubbing animal the guidance of smell impression, whether in the search for food or as a means of recognition of friends or enemies, was much more serviceable than all the other senses. Thus the small creature's mental life was lived essentially in an atmosphere of odors, and every object in the outside world was judged primarily and predominantly by its smell. The senses of touch, vision, and hearing were merely auxiliary to the compelling influence of smell.

Once such a creature left the solid earth and took to an arboreal life all this was changed, for away from the ground the guidance of the olfactory sense lost much of its usefulness. Life amidst the branches of trees limits the usefulness of olfactory organs, but it is favorable to the high development of vision, touch, and hearing. Moreover, it demands an agility and quickness of

[3] Flower and Lydekker, "Mammals, Living and Extinct," 1891, p. 618.
[4] W. K. Gregory, op. cit., p. 269, and pp. 279, 280.



SECOND STAGE OF THE HISTORY.

Langur or Hanumán (*Pygathrix entellus=Semnopithecus entellus*), of southeastern Asia. "In the remote Oligocene, a catarrhine ape, nearly akin to the ancestors of the Indian sacred monkey, Semnopithecus, became definitely specialized in structure in adaptation for the assumption of the erect attitude." The second stage, as we ascend man's family tree, must have somewhat resembled this langur monkey, then, and it was at that stage that the specialization began which led man to diverge from all his relatives of the tree-tops. Photograph from the American Museum of Natural History, New York. (Fig. 1.)

movement that necessitates an efficient motor cortex to control and coordinate such actions as an arboreal mode of life demands (and secures, by the survival only of those so fitted) and also a well-developed muscular sensibility to enable such acts to be carried out with precision and quickness. In the struggle for existence, therefore, all arboreal mammals, such as the tree shrews, suffer a marked diminution of their olfactory apparatus and develop a considerable neopallium in which relatively large areas are given up to visual, tactile, acoustic, kinaesthetic, and motor functions, as well as to the purpose of providing a mechanism for mutually blending in consciousness the effects of the impressions pouring in through the avenues of these senses.

Thus a more equable balance of the representation of the senses is brought about in the brain of the arboreal animal, and its mode of life encourages and makes indispensable the acquisition of agility. Moreover, these modifications do not interfere with the primitive characters of limb and body. These

small arboreal creatures were thus free to develop their brains and maintain all the plasticity of the generalized structure, which eventually enabled them to go far in the process of adaptation to almost any circumstances that presented themselves.

Amongst the members of this group, as in all the other mammalian phyla, the potency of the forces of natural selection was immensely enhanced by the fact that the inquisitiveness of an animal which can learn by experience—*i.e.*, is endowed with intelligence—was leading these plastic insectivores into all kinds of situations which were favorable for the operation of selection. Various members of the group became specialized in different ways. Of such specialized strains the one of chief interest to us is that in which the sense of vision became especially sharpened.

THE ORIGIN OF PRIMATES.

Toward the close of the Cretaceous period some small, arboreal, shrew-like creature took another step in advance, which was fraught with the most far-reaching consequences, for it marked the birth of the primates and the definite branching off from the other mammals of the line of man's ancestry.

A noteworthy further reduction in the size of the olfactory parts of the brain, such as is seen in that of Tarsius,[5] quite emancipated the creature from the dominating influence of olfactory impressions, the sway of which was already shaken, but not quite overcome when its tupaioid ancestor took to an arboreal life. This change was associated with an enormous development of the visual cortex in the neopallium, which not only increased in extent so far as to exceed that of Tupaia, but also became more highly specialized in structure. Thus, in the primitive primate, vision entirely usurped the controlling place once occupied by smell; but the significance of this change is not to be measured merely as the substitution of one sense for another. The visual area of cortex, unlike the olfactory, is part of the neopallium, and when its importance thus became enhanced the whole of the neopallium felt the influence of the changed conditions. The sense of touch also shared in the effects, for tactile impressions and the related kinaesthetic sensibility, the importance of which to an agile tree-living animal is obvious, assist vision in the conscious appreciation of the nature and the various properties of the things seen, and in learning to perform agile actions which are guided by vision.

An arboreal life also added to the importance of the sense of hearing; and the cortical representation of this sense exhibits a noteworthy increase in the primates, the significance of which it would be difficult to exaggerate in the later stages, when the simian are giving place to the distinctively human characteristics.

The high specialization of the sense of sight awakened in the creature the curiosity to examine the objects around it with closer minuteness, and supplied guidance to the hands in executing more precise and more skilled movements than the tree shrew attempts. Such habits not only tended to develop the motor cortex itself, trained the tactile and kinaesthetic senses, and linked up their cortical areas in bonds of more intimate associations with the visual cortex, but they stimulated the process of specialization within or alongside the motor cortex of a mechanism for regulating the action of that cortex itself—an organ of attention which coordinated the activities of the whole neopallium so as the more efficiently to regulate the various centers controlling the muscles of the whole body. In this way not only is the guidance of all the senses secured, but the way is opened for all the muscles of the body to act harmoniously so as to permit the concentration of their action for the performance at one moment of some delicate and finely adjusted movement.

[5] "On the Morphology of the Brain in the Mammalia, with Special Reference to that of the Lemurs, Recent and Extinct," Trans. Linn. Soc. Lond., second series; Zoology, Vol. 8, part 10, Feb., 1903.

THIRD STAGE OF THE HISTORY.

White-throated Sapajou (*Cebus hypoleucus*), a platyrrhine monkey of tropical America. The platyrrhine apes were the ancestors of the catarrhine forms, and therefore represent another step as we ascend the family tree of *Homo sapiens*. It is, of course, not to be understood that this or any of the other mammals shown in this series are considered ancestors of man; but it is to be thought that this Sapajou and the present primates, including man, are both descended from a platyrrhine form of the old world, which has probably undergone very little change in its descent to the sapajou, but from which man's ancestors diverged through forms like the langur and gibbon. Photographed by Elwin R. Sanborn of the New York Zoological Society. (Fig. 2.)

In some such way as this there was evolved from the motor area itself, in the form of an outgrowth placed at first immediately in front of it, a formation, which attains much larger dimensions and a more pronounced specialization of structure in the primates than in any other order; it is the germ of that great prefrontal area of the human brain which is said to be "concerned with attention and the general orderly coordination of psychic processes,"[6] and as such is, in far greater measure than any other part of the brain, deserving of being regarded as the seat of the higher mental faculties and the crowning glory and distinction of the human fabric.

* * * * *

Thus the outstanding feature in the gradual evolution of the primate brain is a steady growth and differentiation of precisely those cortical areas which took on an enchanced importance in the earliest primates.

So far in this address I have been delving into the extremely remote, rather than the nearer, ancestry of men, because I believe the germs of his intellectual preeminence were sown at the very dawn of the Tertiary period, when the first anaptomorphid began to rely upon vision rather than smell as its guiding sense. In all the succeeding ages since that remote time the fuller cultivation of the means of profiting by experience, which the tarsioid had adopted, led to the steady upward progression of the primates. From time to time many individuals, finding themselves amidst surroundings which were thoroughly congenial and called for no effort, lagged behind; and in Tarsius and the lemurs, the New World monkeys, the Old World monkeys, and the anthropoids, not to mention the extinct forms, we find preserved a series of these laggards which have turned aside from the highway which led to man's estate.

The primates at first were a small and humble folk, who led a quiet, unobtrusive, and safe life in the branches of trees, taking small part in the fierce competition for size and supremacy that was being waged upon the earth beneath them by their carnivorous, ungulate, and other brethren. But all the time they were cultivating that equable development of all their senses and limbs, and that special development of the more intellectually useful faculties of the mind which, in the long run, were to make them the progenitors of the dominant mammal—the mammal which was to obtain the supremacy over all others, while still retaining much of the primitive structure of limb that his competitors had sacrificed. It is important, then, to keep in mind that the retention of primitive characters is often to be looked upon as a token that their possessor has not been compelled to turn aside from the straight path and adopt protective specializations, but has been able to preserve some of his primitiveness and the plasticity associated with it, precisely because he has not succumbed or fallen away in the struggle for supremacy. It is the wider triumph of the individual who specializes late, after benefiting by the many-sided experience of early life, over him who in youth becomes tied to one narrow calling.

MAN'S PRIMITIVENESS.

In many respects man retains more of the primitive characteristics, for example, in his hands, than his nearest simian relatives; and in the supreme race of mankind many traits, such as abundance of hair, persist to suggest pithecoid affinities, which have been lost by the more specialized negro and other races. Those anthropologists who use the retention of primitive features in the Nordic European as an argument to exalt the negro to equality with him are neglecting the clear teaching of comparative anatomy, that the persistence of primitive traits is often a sign of strength rather than of weakness. This factor runs through the history of the whole animal kingdom. Man is the ultimate product of that line of ancestry which was never compelled to turn aside and adopt protective specialization either of structure or mode of life, which would be fatal to its

[6] J. S. Bolton "The Functions of the Frontal Lobes," Brain, 1903.

FOURTH STAGE OF THE HISTORY.

The spectral tarsier (*Tarsius borneanus*), a lemur or lemuroid from Borneo which Dr. Smith considers to be the most primitive of the primates. Its ancestors, probably not much different from the tarsier of the present day, are then to be considered the ancestors of all the primates including man. The progress of the tarsioid toward domination of the world is due, the writer thinks, to the development of the prefrontal area of the brain, which gave it the power to profit by experience. (Fig. 3.)

plasticity and power of further development.

Having now examined the nature of the factors that have made a primate from an insectivore and have transformed a tarsioid prosimian into an ape, let us turn next to consider how man himself was fashioned.

* * * * *

THE ORIGIN OF MAN.

In the remote Oligocene, a catarrhine ape, nearly akin to the ancestors of the Indian sacred monkey, Semnopitheeus, became definitely specialized in structure in adaptation for the assumption of the erect attitude; and this type of early anthropoid has persisted with relatively slight modifications in the gibbon of the present day. But if the earliest gibbons were already able to walk upright, how is it, one might ask, that they did not begin to use their hands, thus freed from the work of progression on the earth, for skilled work, and at once become men? The obvious reason is that the brain had not yet attained a sufficiently high stage of development to provide a sufficient amount of useful skilled work,

apart from the tree climbing, for these competent hands to do.

The ape is tied down absolutely to his experience, and has only a very limited ability to anticipate the results even of relatively simple actions, because so large a proportion of his neopallium is under the dominating influence of the senses.

Without a fuller appreciation of the consequences of its actions than the gibbon is capable of, the animal is not competent to make the fullest use of the skill it undoubtedly possesses. What is implied in acquiring this fuller appreciation of the meaning of events taking place around the animal? The state of consciousness awakened by a simple sensory stimulation is not merely an appreciation of the physical properties of the object that supplies the stimulus; the object simply serves to bring to consciousness the results of experience of similar or contrasted stimulations in the past, as well as the feelings aroused by or associated with them, and the acts such feelings excited. This mental enrichment of a mere sensation so that it acquires a very precise and complex meaning is possible only because the individual has this extensive experience to fall back upon; and the faculty of acquiring such experience applies the possession of large neopallial areas for recording, so to speak, these sensation factors and the feelings associated with them. The "meaning" which each creature can attach to a sensory impression presumably depends, not on its experience only, but more especially upon the neopallial provision in its brain for recording the fruits of such experience.

Judged by this standard, the human brain bears ample witness, in the expansion of the great temporo-parietal area, which so obviously has been evolved from the regions into which visual, auditory, and tactile impulses are poured, to the perfection of the physical counterpart of the enrichment of mental structure, which is the fundamental characteristic of the human mind.

The second factor that came into operation in the evolution of the human brain is merely the culmination of a process which has been steadily advancing throughout the primates. I refer to the high state of perfection of the cortical regulation of skilled movements, many of which are acquired by each individual in response to a compelling instinct that forces every normal human being to work out his own salvation by perpetually striving to acquire such manual dexterity.

MAN AND GORILLA.

This brings us to the consideration of the nature of the factors that have led to the wide differentiation of man from the gorilla. Why is it that these two primates, structurally so similar and derived simultaneously from common parents, should have become separated by such an enormous chasm, so far as their mental abilities are concerned?

There can be no doubt that this process of differentiation is of the same nature as those which led one branch of the Eocene tarsioids to become monkeys while the other remained prosimiae; advanced one group of primitive monkeys to the catarrhine status, while the rest remained platyrrhine; and converted one division of the Old World apes into anthropoids, while the others retained their old status. Put into this form as an obvious truism, the conclusion is suggested that the changes which have taken place in the brain to convert an ape into man are of the same nature as, and may be looked upon merely as a continuation of, those processes of evolution which we have been examining in the lowlier members of the primate series. It was not the adoption of the erect attitude or the invention of articulate language that made man from an ape, but the gradual perfecting of the brain and the slow upbuilding of the mental structure, of which erectness of carriage and speech are some of the incidental manifestations.

The ability to perform skilled movements is conducive to a marked enrichment of the mind's structure and the high development of the neopallium, which is the material expression of that enrichment. There are several reasons

FIFTH STAGE OF THE HISTORY.

The squirrel shrew (*Tupaia chrysura*), probably not widely different from its ancestor which gave rise to the lemuroids and thereby to the primates. The arboreal life of this creature undoubtedly had an important part in fitting it to progress upward, since it allowed the senses of sight, touch and hearing to be developed equably, and removed the animal from the fierce competition going on among larger mammals on the ground below him. These changes in habit were accompanied by changes in the structure of the brain, which made further evolution possible. Even as far back as this stage in man's history, the beginning of the use of the fore-feet as hands is seen, as it is with the common squirrels, for the tree-shrews often sit on their hind legs and hold their food in their forepaws. They are largely insectivorous, and are agile, active creatures. The life in the trees of man's ancestors at a similar stage undoubtedly tended to develop this agility and quickness of movement which depends on the coordination of many muscles; and natural selection weeded out those who did not show progress along the chosen line. Thus the growth of the powers of the brain, which has largely contributed to make man the dominant mammal, received an impetus from the arboreal life of his ancestors, the importance of which it is difficult to overestimate. Photograph from the Brooklyn Institute of Arts and Sciences. (Fig. 4.)

why this should be so. The mere process of learning to execute any act of skill necessarily involves the cultivation, not only of the muscles which produce the movement, and the cortical area which excited the actions of these muscles, but in even greater measure the sensory mechanisms of the neopallium which are receiving impressions from the skin, the muscles, and the eyes, to control the movements at the moment, and incidentally are educating these cortical areas, stimulating their growth, and enriching the mental structure with new elements of experience. Out of the experience gained in constantly performing acts of skill the knowledge of cause and effect is eventually acquired. Thus the high specialization of the motor area, which made complicated actions possible, and the great expansion of the temporo-parietal area, which enabled the ape-man to realize the "meaning" of events occurring around it, reacted one upon the other, so that the creature came to understand that a particular act would entail certain consequences. In other words, it gradually acquired the faculty of shaping its conduct in anticipation of results.

MAN LEAVES THE TREES.

Long ages ago, possibly in the Miocene, the ancestors common to man, the gorilla, and the chimpanzee became separated into groups, and the different conditions to which they became exposed after they parted company were in the main responsible for the contrasts in their fate. In one group the distinctively primate process of growth and specialization of the brain, which had been going on in their ancestors for many thousands, even millions, of years, reached a stage when the more venturesome members of the group, stimulated perhaps by some local failure of the customary food, or maybe led forth by a curiosity bred of their growing realization of the possibilities of the unknown world beyond the trees which hitherto had been their home, were impelled to issue forth from their forests, and seek new sources of food and new surroundings on hill and plain wherever they could obtain the sustenance they needed. The other group, perhaps because they happened to be more favorably situated or attuned to their surroundings, living in a land of plenty which encouraged indolence in habit and stagnation of effort and growth, were free from this glorious unrest, and remained apes, continuing to lead very much the same kind of life (as gorillas and chimpanzees) as their ancestors had been living since the Miocene or even earlier times. That both of these unenterprising relatives of man happen to live in the forests of tropical Africa has always seemed to me to be a strong argument in favor of Darwin's view that Africa was the original home of the first creatures definitely committed to the human career; for while man was evolved amidst the strife with adverse conditions the ancestors of the gorilla and chimpanzee gave up the struggle for mental supremacy simply because they were satisfied with their circumstances; and it is more likely than not that they did not change their habitat.

The erect attitude, infinitely more ancient than man himself, is not the real cause of man's emergence from the simian stage; but it is one of the factors made use of by the expanding brain as a prop still further to extend its growing dominion, and by fixing and establishing in a more decided way this erectness it liberated the hand to become the chief instrument of man's further progress.

In learning to execute movements of a degree of delicacy and precision to which no ape could ever attain, and the primitive ape-man could only attempt once his arm was completely emancipated from the necessity of being an instrument of progression, that cortical area which seemed to serve for the phenomena of attention became enhanced in importance. Hence the prefrontal region, where the activities of the cortex as a whole are, as it were, focused and regulated, began to grow until eventually it became the most distinctive characteristic of the human brain, gradually filling out the front of

SIXTH STAGE OF THE HISTORY.

Jumping shrew of East Africa (*Petrodromus tetradactylus*). An ancestral and probably not dissimilar form of this insectivore is to be looked upon as representing man's ancestors in the Eocene period or earlier—a period which is to be dated one or perhaps several millions of years ago. At this time man's ancestors "lived essentially in an atmosphere of odors;" the sense of smell was the only one well developed. When they took to an arboreal life, they emancipated themselves from the dominance of this sense of smell, and thus, Dr. Smith thinks, started on the course which finally led to the evolution of man. Photograph from the Brooklyn Institute of Arts and Sciences.

That tropical Africa may have been the region where man's direct ancestors developed, was suggested by Darwin, and Dr. Smith looks with favor on the suggestion. Ancestors who did not progress, who fell by the wayside, are still there, he points out. It may be supposed that they found their environment perfectly congenial, had no reason to change it, and so stayed where they are and thus lost the impetus to evolution which a change of environment would have given. Man's direct ancestors, for some reason, left their homes and branched out into new fields, where variation and natural selection had a chance to accelerate their development. (Fig. 5.)

the cranium and producing the distinctively human forehead. In the diminutive prefrontal area of Pithecanthropus,[7] and to a less marked degree, Neanderthal man,[8] we see illustrations of lower human types, bearing the impress of their lowly state in receding foreheads and great brow ridges. However large the brain may be in *Homo primigenius*, his small prefrontal region, if we accept Boule and Anthony's statements, is sufficient evidence of his lowly state of intelligence and reason for his failure in the competition with the rest of mankind.

The growth in intelligence and in the powers of discrimination no doubt led to a definite cultivation of the esthetic sense, which, operating through sexual selection, brought about a gradual refinement of the features, added grace to the general build of the body, and demolished the greater part of its hairy covering. It also led to an intensification of the sexual distinctions, especially by developing in the female localized deposits of fatty tissue, not found in the apes, which produced profound alterations in the general form of the body.

[7] Eug. Dubois, "Remarks upon the Brain-cast of Pithecanthropus," Proc. Fourth Internat. Cong. Zool., Aug., 1898, published Cambridge, 1899, p. 81.

[8] Boule and Anthony, "L'encephale de l'homme fossile de la Chapelle-aux-Saints," L'Anthropologie, tome 22, No. 2, 1911, p. 50.

What Eugenics Means.

A plea for more care in the use of the word "eugenics" is made by Roswell H. Johnson in the last number of the *American Journal of Sociology* (XX, 1, 98, July, 1914). He points out the attempt of euthenists to appropriate the word to describe hygienic legislation, sex education, and even a milk and ice station for infants. Such a use, he shows at length, was never contemplated by Sir Francis Galton, who coined the word. He proposes that the term "projected euthenics" be used to cover euthenics that has as its avowed object the bettering of a new generation—for instance, by giving babies a proper start in life. Those who call themselves eugenists may then, he says, "give their whole attention to those problems of heredity and selection which they are peculiarly fitted to handle."

Genetics and Eugenics.

By way of conclusion we may then say that the experimental study of inheritance in plants and animals is one of the main foundations upon which progress in scientific eugenics must rest. Genetics is at once the guide and the support of eugenics. —Raymond Pearl, in the *Eugenics Review* (1911).

Eugenic Legislation.

Legislating may be said to be a favorite American universal panacea for social evils. It is cheap, at least. * * * Is it not time that legislators stopped to think if there is any knowledge extant upon which to base their laws and, if not, to make an appropriation to get the knowledge? Today, if a legislature is urged to cure any social evil it proceeds to look for, and, if found, to copy any other legislation on the subject, but not to spend a dollar on the study of the subject. Very slowly, but I trust none the less surely, will legislation come to recognize that research is a basic function of the State —Charles B. Davenport: Eugenics Record Office Bulletin No. 9 (State Laws Limiting Marriage Selection) (1913)

TELEGONY

A Superstition that Dies Hard—Experimental Evidence from Breeding and Deductions from Embryology—Supposed Phenomenon as Negligible in Eugenics as in Stock-Breeding.[1]

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AMONG the different divisions which naturalists and physicians have amused themselves by creating in heredity, surely none is more remarkable then Telegony. It alone, among all these divisions, has no relation to the line of descent, direct or indirect, between progenitors and offspring. Its principle is that females are *impregnated* by the first males to which they are bred, so that all their subsequent offspring, regardless of their actual father, will show influence of the first male. The latter is thus interposed between direct ascendants and descendants. Telegony, then, is supposedly a phenomenon of particular importance, since it is assumed to be able to modify the inherited constitution of lines of descent among animals; and it is of high interest to examine it just at this time, when eugenics is assuming such a prominent place in the attention of medical men.

As a fact, very serious suspicions rest on the reality of this phenomenon. Even the data cited to support it are not based on exact observations; most, if not all, are the reports of sportsmen or stock-breeders. Even at the present day, these latter jealously keep their female breeding animals carefully guarded, to avoid the chance of their being bred by a male of inferior pedigree.[2] But their affirmations seem to be more the result of simple belief than of scientific observation.

The first report, which has become classic and was sufficient to convert Darwin, goes back to 1821: a mare of almost pure Arabian blood, belonging to Lord Morton, was bred to a quagga and foaled a hybrid. Afterward bred on two different occasions to a black Arabian stallion, she foaled two colts of brown color, whose legs were striped more plainly than those of the hybrid or even than those of the quagga himself; well-marked stripes also existed on the neck and some other parts of the body: the hair of the mane was short, stiff and erect, exactly as is the case with the quagga.

Since 1821, numerous similar cases have been reported. Darwin, among others, cites the following, which was communicated to him by Doctor Bowerbank: "A Turkish dog, black and hairless, having been accidentally bred by a spaniel of mixed blood with long, brown hair, produced a litter of five pups, three of which were hairless, while the other two were covered by short brown hair. When bred later by a Turkish dog, equally black and hairless, she produced a litter of pups, half of which resembled their mother—that is, pure Turk—while the other half were exactly like the pups *with short hair*, sired by the spaniel."

STORIES OF DOG BREEDERS.

In a general way, dog fanciers believe in telegony, and in this manner interpret most diverse occurrences. Thus Kiener writes, in his "Observations on Hered-

[1] Translated from Biologica, IV, 41,129, Paris, 15 mai, 1914.

[2] It would be a mistake to think that this statement applies without qualification to the United States. Most cattle, horse and swine breeders now disregard telegony; but dog and sheep breeders, as a rule, still adhere to the idea, and several sheep breeders' associations even refuse to register lambs whose mothers were ever "impregnated" by mating with a common ram.—The Editor.

ity" (1900): "I got from an artesienne bitch, bred to a splendid male of her race, a pup with 'wall' eye. She had previously been bred to a huge mastiff which had that peculiarity." Kunstler, on his part, reports (1901) that a French braque was first bred to an Irish setter and then to a blue braque of Auvergne, and then, by a third male—a Gordon setter—had pups resembling the Irish setter, and by a fourth male (an Irish setter) had a litter of pups, one of whom looked like the Gordon setter.

Resemblances, attributed to the same phenomenon, have been reported among sheep and goats, cattle, horses and swine. White ewes covered by black rams are said afterward to have borne pigmented lambs, even when bred to white rams. A cow of the Angus breed—characterized by absence of horns—first bred to a shorthorn bull, is alleged afterward, when bred to a polled Angus bull, to have produced a calf with horns, which looked like a grade Shorthorn. And as for horses, almost every breeder believes that colts foaled by a mare which has been previously bred to a jack, have a more or less mulish appearance. Cousin, in his excellent study (1904), relates that in Poitou popular belief considers mares as "interiorly mulish" and attributes that condition to the fact that for many years the mares of that region have been constantly used for the production of mules. The same writer quotes the observation of Bernardin (1901), relative to a mare whose first two offspring were two mules. Afterward bred to a heavy Arab stallion, she foaled successively:

(a) A colt of irreproachable form, very easy-gaited, whose feet alone, recalling those of its mother, were a trifle unsatisfactory;

(b) A colt which "showed, with certain diminutions, all the characters of a mule: the head, the mane, the neck, the withers, the back, the rump, the feet, the gait and, above all, the proverbial disposition."

These few examples are enough to state the problem, while showing the kind of evidence that has led to its acceptance. I have taken the most classical examples, and the most convincing ones, too. Should they be accepted without discussion, as the expression of facts rigorously controlled and rigorously interpreted?

Not one of them, as a fact, is beyond criticism, and it appears that a careful examination leads us to give to each case a different explanation, which is not necessarily the same in every instance.

VALUE OF THE EVIDENCE.

At the start, it must be insisted that facts alleged to show telegony are never the result of carefully controlled experiments, nor even of observations which take all the circumstances into consideration. When a breeder talks of "pure bred," he refers to similar individuals which, bred together, usually and exclusively give offspring that resemble their parents; he refers, then, to a fixed race, but fixed only in these conditions, and he pays no attention whatever to things that happen outside these conditions. As a matter of fact, he can not really know whether the animals under consideration actually belong to one of these "pure breeds," carefully selected. The white mice furnish the best proof of this statement. No "race" is better fixed. Bred with each other, white mice continue indefinitely to produce descendants of the same color. And yet, this uniformity, like this fixity, conceals notable differences which make themselves evident when one of these white mice is bred to a wild gray[3] mouse. The posterity of a number of white females mated to the same gray male will include diverse individuals, whose variations can not necessarily be compared to the differences between one female and another. The posterity of some females will comprise nothing but gray and white individuals; but that of others will show, in addition, yellows, blacks, striped grays, striped blacks, etc. Often, if the matings were

[3] This color is technically known as *agouti*, and is considered to be the ancestral color of many small mammals, including mice, rats, rabbits and guinea pigs.—The Editor.

not rigorously controlled, one would feel compelled to suggest telegony. In reality, the explanation is found in the genealogy of the white mice. One can certainly find—and we will notice some of them—similar results among all sorts of animals.

After that, when a French braque bitch, first mated to a Gordon setter and then to an Irish setter, produces pups which differ both from her and from the Irish setter, it would be a good idea, before talking about telegony, to try the same matings separately with bitches that have never before been bred.

Similarly, when Lord Morton's mare, stated to be seven-eighths Arab, is bred by a stallion of pure Arab blood, there is nothing to prove that the zebra-like stripes and other peculiarities are traces of the zebra which fecundated the mare for the first time; they can just as easily be produced when the mare is bred to a black stallion. And as a fact, the stripes, in particular, have not the slightest importance. We know, now, that they appear rather commonly among horses, when there is not any possible reason to suspect the intervention of a zebra. Darwin himself, who unreservedly admits the fact of telegony, at the end of the first volume of this "Variation of Animals and Plants under Domestication," gives at the beginning of the same volume a series of examples showing that zebra-markings do not constitute a valid proof. Among others, there is the case of a brown Devonshire pony which "had on its back a very distinct stripe along the spine, light transverse rays on the inside of the legs, and four parallel bands on each shoulder." In volume II, Darwin considers these stripes to be the result of a cross between individuals of different color, and as constituting a case of "atavism." This last hypothesis opens up a different question altogether—we are absolutely in ignorance, and so was Darwin, whether the ancestors of the modern horse were or were not striped. It is a matter of little importance, anyhow; it is enough for us to know that the birth of a colt with stripes is far from being sure evidence that its mother had been previously fecundated by a zebra.

A STRIKING CASE.

In support of this statement, Nathusius brings up a well-ascertained fact: a light bay mare, five times bred to a stallion of pure blood, foaled five colts with the same coat color. Afterward bred to a dappled gray stallion, she foaled a colt on whose back, shoulders and lower legs were stripes perhaps even more distinct than those on the offspring of Lord Morton's mare.

One can not argue from the appearance of the mane, either, to sustain the theory that a colt shows zebra characters. A short, erect mane is found in many breeds of horse, particularly among the ponies.

Thus, the ignorance of breeders as to the origin of their "pure breeds," and the absence of any control of experiments in their breeding, demand that we exercise great caution in accepting their conclusions on this subject.

Nor is that all. Let us not forget that in any stock, at any moment, a morphological variation of great or small importance may appear: hornlessness in cattle, taillessness in cats, mice and rats, the cerebral hernia which produces the so-called crest or hood in fowls, merino sheep, niata cattle of Chile (with undershot jaws like bulldogs), the franqueiro cattle of Brazil (with long, spiral horns), appeared thus, without anything to allow us to invoke the influence of telegony. We ought, then, always to suspect a coincidence of this sort when we are in the presence of a unique fact, which no experience or control observation corroborates.

Finally, there is one more way in which an honest observer may be deceived. I refer to superfetation—that is, the possibility that females may be bred twice with an interval of some hours or days, by two different males, and may produce offspring some of which are due to the first male and some to the second. There is no room for doubt about the reality of superfetation among dogs. Engelmann, von Rath, Tornier and others have reported in-

disputable facts. Among horses, there are the remarkable cases of mares mated first with an ass and later with a stallion, which foaled twins, one a mule and the other a colt, and each one, as Chauveau remarks, "bearing its special characteristics absolutely distinct." It will at once be understood how an unknown superfetation may be interpreted as telegony. And in spite of the care with which they are watched, a cow, a bitch or a ewe may very well be bred by different males two or three times at short intervals, without the knowledge of the breeder.

ALL EVIDENCE DUBIOUS.

Thus, the positive observations of telegony are all suspected in different degrees because, generally incomplete and conducted without exactitude, they do not eliminate the possibility of a different interpretation. And after that, it is to be feared that they also include a good deal of imagination. For you must not forget that the same breeders who carefully guard their pure-bred female stock to avoid telegony through interbreeding with mongrel males, also carefully guard their pure-bred male stock to avoid a similar result from interbreeding with mongrel females. They have the same fears for both sexes, and legitimize them by the same peremptory affirmations. Cousin reports, in this connection, the following:

"A breeder has a pure-bred Norman bull and pure-bred cows of the same breed; he has always had pure-bred calves. The bull is mated with a Jersey cow, and immediately afterward to a Norman cow; the latter produces a Norman calf which looks like a grade Jersey."

If it is difficult to know just what may have happened, it is in any case certain that any infection of the male by the female is impossible, unless in the form of a bacteriological infection. And if the calf of the second cow really presented unexpected characters, not imputable to her being bred a second time, it is absolutely necessary to fall back on the explanation of a variation due to unknown cause. But is it not enough to establish the necessity of this explanation in the present case, to make it legitimate when the case concerns a female fecundated by two different males?

Along the same line, it is well to remember that influence of a first impregnation has been alleged among birds, too, particularly pigeons and domestic fowls. Brahma hens, for example, fertilized by a Houdan cock, are said to have laid eggs, much later, when penned with Brahma cocks, which produced chickens resembling in certain respects the Houdan. But it is certainly difficult to see how such an impregnation could take place in oviparous females.

Should we henceforth reject telegony without further formality, merely because of the inadequacy of the proofs alleged? Evidently not. Precise observations and experiments are necessary, above everything else. Neither the one nor the other is scarce at present; the oldest date from 1872, due partly to Settegast and partly to Nathusius.

The former records the case of four mares bred first to asses and then to stallions: not one of the colts showed the slightest resemblance to a mule; *nor did their posterity show such resemblance, either.*

Nathusius cites, among other illustrations, the following: An Ayrshire cow had, by a hornless bull, a hornless calf; all her later calves, gotten by horned bulls, bore horns.

COSSAR-EWART'S WORK.

More recently, J.Cossar-Ewart undertook an extensive investigation of the subject, which lasted from 1896 to 1901. It comprised 13 mares, four of which were used for control experiments while the other nine were successively bred first to a zebra and then to a stallion, or vice versa. The results are summed up in Table I.

TABLE I.

Couples	Date of Foaling	Descendance
Walda x zebra	1898	hybrid twins
x stallion	1899	colt without resemblance to zebra
x zebra	1900	hybrid
x stallion	1901	colt without resemblance to zebra
Mulatto		
x zebra	1896	hybrid
x stallion B	1897	colt lightly striped at birth
x stallion L	1899	colt lightly striped at birth (Note.—The stallion L gave, with two fillies, striped colts like those of Mulatto).
Nora x stallion W	1895	colt bearing several stripes at birth; three persisted on the sholder.
x zebra	1897	hybrid.
x stallion C	1898	colt without stripes or any resemblance to zebra.
x zebra	1898	hybrid.
x zebra	1900	hybrid.
x stallion S	1901	colt like its sire, without stripes or any resemblance to a zebra.
Laura		
x zebra	....	abortion.
x stallion L	1898	colt without any resemblance to a zebra.
x stallion L	1898	colt without resemblance to zebra.
x stallion S	1900	colt without resemblance to zebra.
Rona x zebra	1898	hybrid.
x stallion M	1899	colt bearing no traces of zebra.
Lady Douglas		
x zebra	1897	hybrid.
x zebra	1898	hybrid.
x stallion M	1900	colt bearing no resemblance to zebra.
x stallion S	1901	colt bearing no traces of zebra.
Biddy		
x zebra	1897	hybrid.
x stallion T	1898	colt (Kathleen) without resemblance to zebra.
x stallion G	1898	colt bearing no traces of zebra.
x stallion G	1900	colt bearing no resemblance to zebra.
Kathleen		
x stallion M	1901	colt bearing no resemblance to zebra.
Timdra		
x zebra	1897	hybrid.
x stallion B	1898	colt having no resemblance to zebra.
x zebra	1899	hybrid.
x stallion S	1900	colt bearing no traces of zebra.

This table constitutes an important argument against the doctrine of telegony. In the cases of eight of the mares, the lack of influence of the fecundation by a zebra is, *morphologically*, indisputable because not one of the colts born after the hybrids is marked by stripes of any kind. The colts foaled by the mare *Mulatto* by the stallion B and then by the stallion L, after the birth of a hybrid, alone show stripes. These stripes are not persistent; nevertheless,

they would have been quickly seized upon as evidence in favor of telegony, had not J. Cossar-Ewart had control experiments going on at the same time. In these, two mares which had never before been bred, were bred to the same stallion L and each one foaled a striped colt, very similar to the two colts of Mulatto. The influence of the zebra therefore becomes more than doubtful for her two colts, as well for the one sired by stallion L as for the one sired by stallion B.

The progeny of the mare *Nora* also merit special mention. Bred to the stallion W, before she had ever seen a zebra, she foaled a colt which, *richly striped at birth, kept three permanent stripes on the shoulder;* bred then to a zebra, she foaled a hybrid; finally, she was bred to the stallion C and foaled a colt without the least sign of stripes. Again bred, in two different seasons, to a zebra, she produced two more hybrids; and finally bred to the stallion S, she foaled a colt which bore not the least resemblance to a zebra. Thus the only striped colt, which could have given hope to the advocates of telegony, is the one first foaled, at a time when the mare had never been bred to a zebra. All the other colts, born after the hybrid crosses, showed no resemblance to a zebra. This example shows once more

TABLE II

Mares	Date of Foaling	Progeny	Characters
Litvinka (brown) born in 1893	1897	zebroid (aborted)	
	1898	foaled a zebroid	
	1902	foaled a zebroid	
	1905	zebroid (aborted)	
	1906	foaled a colt by half-blood Arab "Lebed"	no stripes
	1907	foaled a zebroid	
	1908	colt by Lebed	no stripes
	1909	colt, sire unknown	no stripes
Pliakha (piebald) born in 1896	1901	foaled a zebroid	
	1902 to 1910	foaled nine colts	none striped
	1912	colt by thoroughbred sire	no stripes
Armida (bright bay), born in 1899	1902	foaled a zebroid	
	1904	foaled a colt by half-blood sire	no stripes
	1906	foaled a colt by half-blood sire	no stripes
	1907	foaled a colt by half-blood sire	no stripes
Priimikha (brown) born in 1898	1905	foaled a zebroid (artificial insemination)	
	1906	foaled a zebroid (artificial insemination)	
	1907	foaled a zebroid (artificial insemination)	
	1908 to 1912	foaled five colts	none striped
Vesta (bay) born in 1901	1906	foaled a zebroid	
	1907	foaled colt by thoroughbred sire	no stripes
	1908	colt by same sire	no stripes
	1912	foaled colt by thoroughbred sire	no stripes
Aida (piebald) born in 1902	1907	foaled a zebroid	
	1908	foaled a colt	no stripes
	1909	foaled a colt	no stripes
	1911	foaled a colt	no stripes
Zlodeika (dark brown) born in 1890	1902	foaled a zebroid	
	1903 to 1907	foaled four colts by half-blood sire	none striped

how carefully we must avoid giving to mere coincidences the value of evidence, in this inquisition.

One more fact should be emphasized. It might happen that a colt without any visible resemblance, in form, to a zebra, should yet have something of the zebra in its constitution; this would then show itself, or at least might show itself, in the progeny of the colt. Now the mare *Kathleen*, foaled by *Biddy* subsequent to the birth of a hybrid, herself foaled an absolutely pure colt. This fact corroborates an analogous one of Settegast. It should be added nevertheless that as the characters of the zebra appear to be "dominant" in all crosses with the horse, this objection has only slight weight; since if there were any stripes or other anatomical characters transmitted, they ought to appear in the first generation.

CONFIRMATORY PROOFS.

Besides, the not less important investigation of Faltz-Fein and H. Ivanov (1913) confirms all the preceding conclusions. In no case did colts born after hybrids show any indications of influence of the zebra. And yet two of the mares (*Litvinka* and *Priimikha*) were in a position to have shown effects, if it were possible, of having been strongly impregnated, because one of them had been bred five times and the other three times to a zebra. Table II summarizes this investigation.

Outside of horses, we possess experiments in full agreement with these: Faelli (1900) reports the case of a Tamworth sow successively bred to a Tamworth boar, a Yorkshire boar, and a second Tamworth boar; all of the pigs sired by the Yorkshire resembled him, while all of the pigs by the second Tamworth male resembled their sire without the slightest trace of Yorkshire characteristics.

Cousin (1904) also cites a number of cases. A shorthaired greyhound bitch bred to a griffon produced a litter of pups of varying aspects; later bred to a male like herself, she produced pups without the slightest appearance of the former mate. A Saint Germain braque crossed with a spaniel produced a number of pups which showed various evidences of cross-breeding; later mated with a male of her own breed, she produced a litter of typically pure-bred pups. With sheep, Cousin mated Berrichon ewes successively with a merino ram and then with a Berrichon ram; none of the products of this last mating showed the slightest trace of merino blood. It is to be remarked that the products of the merino-Berrichon cross look very much like the merino male, which means that, in Mendelian language, the merino characters are to some extent dominant over the Berrichon characters; they ought, therefore, to reappear in the succeeding lambs of the ewe, if she had really become impregnated.

I come now to the experiments carried out by Bond (1899) with rabbits and white rats, and by Miss Barthelet (1900) with white mice.

Bond mated a Himalayan rabbit (white with black feet) to a wild male, and then to an albino male. The first litter due to this last buck contained several individuals of a gray tint; but the following litters by the same male contained only albino individuals, although between each successive mating with an albino male, there was a mating with the wild buck. Were the gray offspring of the albino male, at first mating with him, due to the influence exercised by the wild male which had previously been bred to the female? That color is to rabbits like stripes to horses. Rabbits of the Himalaya breed possess pigment, because their feet are black, and the vague tint observed in the young is due to that pigment, the existence of which can not be disputed, much more certainly than to any mysterious influence which remains to be proved. It is even common that the crossing of a striped animal with one not striped produces offspring that are not striped, regardless of their color; and this is the case here. Besides, is it not remarkable that the gray tint was not repeated in succeeding litters, when conditions were most favorable for impregnation?

With rats, Bond proceeded in the following manner: an albino female was first mated to an ordinary brown male, and then to an albino male; with the latter she produced none but albino offspring.

Miss Barthelet proceeded in the same way with white mice: first mated with a gray male, they were later mated to an albino and produced only albinos, with no trace of gray.

THE CASE OF ALBINOS.

I must now point out that these two latter experiments have really no significance, either for or against telegony, because there is an important source of error in them. If the numerous researches into the inheritance of coloration during recent years have shown anything, it is that albinos mated with each other (rats or mice) produce albinos indefinitely, whatever be the origin of these rats or mice. In my own work I have mated white mice, born from gray ones, with white mice born from black ones, without ever obtaining offspring bearing a single gray or black hair. So even if we should admit the impregnation of a white mouse by a gray one, that impregnation could not manifest itself as the result of fecundation by a white male; the results obtained in the experiments just mentioned prove nothing, therefore, as regards telegony.

But rats and mice form, none the less, excellent material for the study of telegony; because even if, mated with each other, albinos produce only albinos, the identity of coloration does not conceal important constitutional differences, as I have already pointed out. These differences appear if a wild gray mouse, for example, is mated with an albino born of a striped black or striped gray; black or striped offspring will necessarily appear in the second endogamous generation, thus bearing witness to the influence of the ancestry of the albino.

Reasoning from these experiences, I mated white mice having neither black nor stripes in their ancestry, and wild gray mice, with a striped black male. The members of the first filial generation were all uniformly gray, and all alike, as usually happens. Mated with each other these mice in their turn furnished gray, black and striped mice, thus proving that the general constitution of the first filial generation can, in certain conditions, show itself by the black coloring or striping. In consequence, if the impregnation of the mother really took place, she ought to be able to reveal it by transmitting black coloration or striping.

EXPERIMENTS WITH MICE.

To provoke its appearance, I substituted for the striped mouse a wild gray mouse in whose ancestry there was not, to my certain knowledge, any individual either black or striped; the appearance of such individuals in the posterity of these females, previously mated to the striped male, would then have been a very strong presumption in favor of telegony. None appeared. All the litters obtained, with one exception, contained nothing but gray mice, quite uniform in appearance.

I have noted one exception: it is interesting from several viewpoints, and particularly from that of telegony. One litter contained three wild-gray mice and two light gray ones with a brownish tint. If this tint had been darker, I should have been led to admit the possible of a telegonic impregnation; if it had been lighter, such an interpretation could not have been supported, for it amounted to no more than a difference in color among the different mice. In many cases, nothing more than this has been necessary to "prove" the influence of a previous sire. Here, however, the difference of tint offers no such explanation, because other wild albino couples, the female of which had never been mated with a striped male, furnished me with absolutely analogous results. Nothing remained but to await the result of matings between the different individuals of this F_2 generation; none of the matings thus made resulted in any trace of a black mouse or a striped one.

I made another experiment along slightly different lines, starting with the

idea propounded by various writers that albinism is an infectious disease. According to this hypothesis, a wild-gray female mated to a white male might later produce albinos, even though mated to another wild-gray male. The females submitted to this test did not at all confirm the proposition of the hypothesis: the product of wild pairs has been constantly and uniformly gray.

Thus all the experiments made with various animals in the endeavor to find effects of telegony under controlled conditions have given results absolutely contrary to that doctrine.[4]

WHAT REALLY HAPPENS.

Really, should we be surprised? Could we not think, *a priori*, that the question was, in fact, poorly stated? In reply, it is sufficient to try to find some means by which such an impregnation could take place.

Various mechanisms have been successively proposed. Some of these suggestions have lost all value in the light of present-day knowledge. The advance of knowledge has thus disposed of the idea of incomplete fertilization of mature ova (proposed by Weismann) and of the persistence of spermatozoa in some fold of the reproductive passages (as Claude Bernard suggested).

Others seem unsatisfactory. Romanes, for instance, thinks that the sperm, after penetrating into the uterus, is absorbed by the maternal organism and exercises an influence on ova that are not yet mature. But in truth it does not seem that the protoplasm thus absorbed can have any very different effect from that produced by the absorption of any other substance whatever. This protoplasm does not play the part of a fecundating agent; it does not reach the ovule until it has been very radically changed by contact with the protoplasm of the cell-tissues of the walls of the uterus which absorb it and that through which it must pass; so that if any modification of the protoplasm of the immature ova took place, it would be some modification of the same kind that results from the absorption of some common alimentary substance; the spermatozoa could not produce, except under highly improbable conditions, a modification in the ovules, which would recall the characteristics of the male in question.

The only theory which rests to a certain extent on a solid foundation of fact is the one proposed by W. Turner, adopted by Cornevin, and by the latter expressed as follows:

"Would not the persistent influence of a first reproductor result from the fact that the mother herself had been materially impregnated by something belonging to the male, not by the direct action of the sperm, but by the intermediation of the fetus? Might it not happen that the latter possessed in its blood special properties belonging to its father, and that when its blood was exchanged with that of its mother, it might act on the latter as vaccin acts on the blood of a vaccinated subject? The mother's blood, thus impregnated, would act upon the ova which would be later fecundated by another reproductor."

THE EXCHANGE OF BLOOD.

The existence of exchanges between the blood of a mother and the blood of her fetus can not be the object of any serious controversy. Not only is the passage of toxins from the one to the other indisputable, but it is also known that a sort of equilibrium is established between the constitutions of the two serums. The experiment of Carlson and Drennon (1911) confirmed by E. Lafon (1913) is an irrefutable demonstration of this. These experimenters removed the pancreas of a pregnant bitch toward the end of her gestation; no trace of sugar appeared in her urine as long as fetuses remained in her uterus; but glycosuria became manifest immediately after the expulsion of the last of her pups; the quantity of sugar changed from 0 to 25 grams in the course of 48 hours.

[4] For an illustrated account of the latest such experiment see "The Grevy Zebra as a Domestic Animal," by George M. Rommel; American Breeders Magazine, IV, 3,129, Washington, D. C., July-September, 1913.—The Editor.

All the evidence indicates that the pancreas of the fetus completely took the place of the pancreas of the mother, which is the same as saying that the constitution of the maternal blood was equivalent, from that point of view, to the constitution of the fetal blood. Under the circumstances, the former indubitably derived from the latter.

The important point is to notice that constitutional equivalence did not exist after parturition; it depended strictly on the incessant exchanges of fetal serum with maternal serum. The result of the experiment will not permit us to go beyond that conclusion; and this result leads us to the belief that the influence of the fetus on the mother, in the circumstances observed, is but a momentary influence: soluble products filter through the placenta and parasitic organisms pass through it.

Henceforth we are in a position to put the question on the proper basis. Enlarging the interpretation of this experiment, shall we admit that in addition to the diverse products of the activity of the organism, the blood also contains the "character" of the animal considered, or at least the substances which determine these characters, and that these substances, transmitted by the fetus to the mother, become permanent constituents of the latter? For everything is there; and impregnation, as it is understood, necessitates the transmission of fully determined characters: stripes, colorations, forms of hair, absence or presence of horns, etc. Once this was believed to be the reality, and such a belief served as an argument against the transfusion of blood. Alain Lamy, of Caen, declared in 1668, in the *Journal des Sçavants* "that it was to be feared that, transfused, the blood of a calf would communicate to a man the stupidity and brutal instincts of that animal." The author also demands to know what becomes, in the veins of a man, of the particles of blood destined, in the calf, to produce the horns.

At the present day we are forced to reject such an interpretation. If it was really based on fact, telegonic phenomena ought to be produced with extreme frequency, as a result of the use of serotherapy alone. Besides, the experiments described above, not to say the most elementary logic, fully prove that the peculiarities of an animal do not promenade in its blood, but that they are the very substance of that animal. And since the spermatozoon does not intervene directly in impregnating the ovum, it certainly does not intervene indirectly by the intermediary of the fetus, in the constitution of which it has become a part. We must, then, deliberately reject all idea of the transmission of definite characters, conformation or coloration of parts, of a given male to the descendants of another male, by the impregnation of a female.

REAL EFFECT OF EXCHANGES.

Nevertheless, since exchanges take place between the fetus and the mother, since these exchanges provoke a transformation in the maternal serum sufficient, for example, to furnish a substitute for the internal secretion of the pancreas, is it plausible, that that transformation should wholly disappear after parturition, that the maternal constitution should again become exactly what it was prior to gestation?

Evidently not! Every change induced in an organism necessarily leaves traces after it. But these traces do not and can not have anything to do with the supposed process of telegony. Beyond any doubt, the maternal organism has been placed, during gestation, under conditions of life very different from the antecedent conditions, and from these conditions a modification necessarily results. But that modification is as much a function of the maternal organism as of the condition in which it is found; the fetus does not impose its own constitution on its mother, no more than the temperature imposes on organisms on which it acts the "constitution" of heat-radiation. In fact, the exchanges between fetus and mother result in a new state for the latter, different not only from her antecedent state, but from that of her product. The maternal organism is not "impregnated" in any degree; the real phenomenon therefore

has no relation to the supposed phenomenon. The female does not receive from the male which fecundates her, anything which belongs essentially to that male; the constitution of that female does not become in any degree the image of that male, and there is no reason for surprise if the offspring of that female by a second male give no hint of the first male.

In fact, the question is quite different. Gestation naturally produces in the female a modification which we must suppose to be to some extent permanent. As a consequence, the female which produces a second offspring is no longer the female that produced the first offspring; whether the two gestations be due to the same male or to two different males, the fetus of the second gestation evolves in conditions different from those surrounding the fetus of the first gestation. But it does not undergo in any way the influence of the first male; in reality, what takes places is as if two different females were involved, mated with the same male or with two different males.

Such is the conclusion to which the experimental facts have logically led us. Can we draw from them any lessons relating to the improvement of breeds, particularly of the breed of mankind? If telegony, in its strict sense, could be considered a fact, the course to be pursued would promptly be indicated: every female impregnated by a male of inferior quality ought to be rejected. But under the circumstances what shall we do? Though a first gestation has certainly modified the female, we are ignorant of the direction of that modification; further, we have no way of finding it out. The quality of the male gives no information on this point. Since the change which has taken place is not the passage from the male to the female of the qualities of the male, but the result of exchanges between fetus and mother, this result may be good or bad—eugenically speaking—by reason of conditions which at present we are unable to appreciate.

FACTOR IS NEGLIGILBE.

The only line of action possible for us, therefore, is to neglect this factor, being persuaded anyhow that it is really negligible. The change which gestation produces in a female can not be, *in normal condition*, anything but an insignificant change; the important thing is to reckon with abnormal conditions, when a genuine infection is produced by infectious germs.

* * *

Telegony is not a mode of heredity. The latter is, in itself, a phenomenon of sufficiently complicated mechanism, without the necessity of adding to its study parasitical viewpoints which complicate it without gain. There are no other progenitors than direct ones; a previous gestation carries with it no predetermined effects; it is only one of the conditions which go to make up the general condition of the female at the time of her second gestation; but that general condition is in no sense the "warehousing" in any way of characters belonging to the first male. It is a result of the continued influence of the environment upon the organism. It is, then, an entirely new condition, and we do not have any means of foreseeing its exact nature. These facts must be borne in mind, whenever the question of heredity is involved.[5]

[5] It is customary to connect telegony with xenia. This name is given to the following phenomenon: when a plant is fecundated by pollen of another species, the resulting seed and fruit ordinarily resemble the seed and fruit which would have been produced by fecundation with pollen of the same species. Now it sometimes happens that the fruit recalls in appearance the fruit of the species which furnished the pollen. But this phenomenon does not seem to be identifiable with the phenomenon of telegony. Admitting that the pollinated ovule exercises an influence upon the tissues of the fruit, it certainly does not exercise such an influence upon subsequent fruits. Besides, there is reason to believe that xenia results from pollen grains going astray outside the ovule and, consequently, that there is an impregnation in the positive sense of the word.

A KAKI CLASSIFICATION

Japanese Persimmon Probably a Conglomerate Species—Only Satisfactory Method of Arranging Its Varieties Seems to be on Basis of Behavior When Pollinated—Influence of Seed on Fruit.

H. Harold Hume, *Glen Saint Mary, Florida.*

When any kind of fruit is represented by only a few varieties, it is an easy matter to remember all the characteristics and peculiarities by which these varieties may be distinguished from one another. It is not necessary to classify them and moreover it is hardly possible to do so as the variations are not sufficiently numerous to establish the group boundaries by which each variety should be confined and at the same time separated from its relatives. But as the number of varieties of any kind of fruit increases, it becomes impossible to remember the characteristics of each and every variety, and it becomes necessary to introduce some system of classification to enable the pomologist more easily to identify and handle them. The first step that the systematic pomologist finds necessary in taking up any kind of fruit represented by numerous varieties is to arrange them into a number of classes or groups, placing those which present some well marked characteristics by themselves, and defining them by those characters, then separating out another group on other lines, and so on, until the whole list of varieties has been divided up and separated.

The number of varieties of *D. kaki* grown in the United States for many years has been quite limited. But recently a large number of new varieties have been introduced and it now becomes imperative that all varieties, both old and new, should be classified into easily recognized groups.

In 1904, the writer classified[1] all varieties of *D. kaki* available at that time, dividing them into three groups, viz: *light fleshed*, *mixed fleshed*, and *dark fleshed* varieties. This system of classification was founded on insufficient knowledge of the behavior of *D. kaki* fruit and is now known to be worthless.

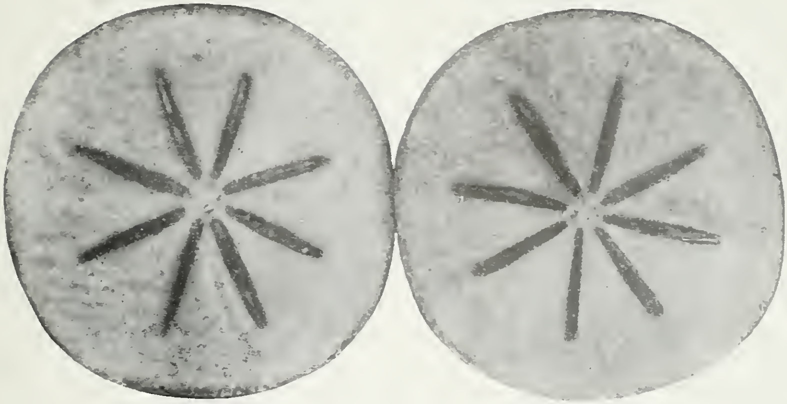
In the bulletin on Japanese persimmons from the Horticultural Experiment Station, Okitsu, Japan, they are divided into *Sweet* and *Astringent* varieties. This grouping may be satisfactory in a measure, but, if the conditions are the same as with us, it is certain to lead to confusion. The chief objection is that when varieties in the *Sweet* group are seedless they fall into the *Astringent* group. Now, any system which permits of a variety being transferred from one group to another owing to the vagaries of circumstance is not likely to prove satisfactory. In other words, the basis of grouping is not stable, it is in itself a variable character and is therefore untenable.

A SOUND BASIS.

In searching about for a basis of classification, rendered necessary by the very large introductions of new varieties from China, Japan, Algeria, France and elsewhere, as well as by the bringing together of all varieties now in America, it has finally been decided that the flesh characters upon which the first American classification was based form a satisfactory basis of classification if applied in their proper significance. In the final analysis the flesh characters are fixed by the pollination factor and this factor finds its most striking expression in the color and texture of the flesh.

It is only within recent years that we have been able to explain some of the

[1] Hume, H. Harold and Remier, F. C. Japanese Persimmons. Bul. 71, Florida Agricultural Experiment Station. Mar. 65–110. 1904.



A SEEDLESS JAPANESE PERSIMMON.

This variety (Zengi) belongs to the group of Pollination Variants. If pollination of the fruits is prevented, they yet develop normally, but the absence of seed results in a light color of the flesh. (Fig. 6.)

mysterious things about the fruit of *D. kaki.* It was noted long ago that the fruits of certain varieties when they contained seeds were different[2] in color of flesh from the seedless specimens, and in the case of certain other varieties it made no difference in the color of the flesh whether seeds were present or not. But the underlying cause of this was not known, and it is indeed not fully understood yet, but it is now known that the development of seeds and the accompanying darkening of the flesh in those varieties in which the peculiarity occurs is due to pollination.

The parthenogenetic development of seeds in *D. virginiana*, the common persimmon of the southern United States, has been suggested on circumstantial evidence by a number of writers, but experimental proof appears to be lacking and the presence of perfect or staminate flowers on supposedly pistillate flowering trees has not been excluded.

Hague[3] found no evidence of parthenogenesis in numerous studies of the embryogeny of *D. virginiana*. Thus far in the writer's experiments not a single case of seed development has been found in fruits developed from carefully bagged flowers of *D. kaki*. The natural conclusion is that parthenogenesis does not occur in *D. kaki* and if it does it is of such rare occurence under conditions in the southern United States as to have no practical bearing on the problem.

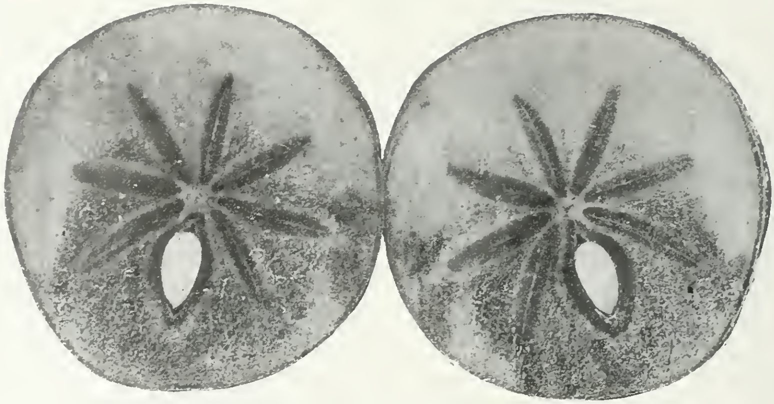
All varieties of *D. kaki* known in America at this time are light fleshed when seedless, while certain varieties always show darkening of the flesh when seeds are present and other varieties are always light fleshed when seeds are present.

THE CLASSIFICATION.

Based on the difference in flesh coloration under influence of pollination, Kaki may be divided into at least two groups—first those which show no change in color of flesh under the influence of pollination and second, those in which the flesh of the fruit is darkened under the influence of pollination. Since the change in color in the one case is directly due to pollination and in the other pollination has no effect whatever, we shall refer to those varieties which undergo no change in color as *Pollination Constants* and those which are light colored when seedless and dark

[2] Van Deman, H. E. The Kaki. The First Report of the Secretary of Agriculture, 1889, 449–450.

[3] Hague, Stella M. A Morphological Study of *Diospyros virginiana*, Botanical Gazette 52: 34–44. July, 1911.



THE INFLUENCE OF A SINGLE SEED.

The influence of pollination in some varieties of Kaki is to darken the flesh. In this variety (Zengi) one seed produces a distinct darkening of the flesh around it, but it is not sufficient to darken the whole area of the fruit. (Fig. 7.)

colored when seedy, we shall call *Pollination Variants*. Now, all varieties of *D. kaki* growing in this country or elsewhere may be referred to one or the other of these groups. If varieties which are constantly dark fleshed whether seedy or seedless should be found, the group of *Pollination Constants* can then be divided into two groups of light and dark fleshed *Pollination Constants*. It is hardly probable that there are varieties which are dark fleshed when seedless and light fleshed when seedy, but if any such should be discovered, a similar plan can be followed by dividing the group of *Pollination Variants*.

The varieties with the fruit of which we are acquainted at this time divide along these lines of classification as follows:

Pollination Constants. Group I.

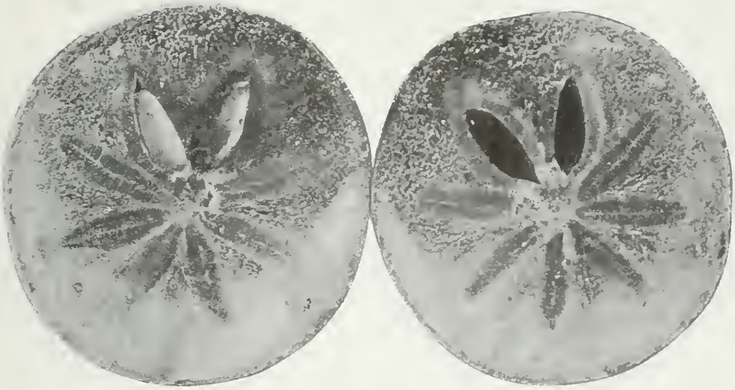
Costata, Hachiya, Lienhua (No. 22367) New Sien (No. 22368), Ormond, Phelps Siang (No. 21910), Tamopan, Tanenashi, Triumph, Tsuru.

Pollination Variants. Group II.

Dai Dai Maru, Gailey, Godbey, Hyakume, Lonestar, Masugata, Myotan, Nectar, Okame, Taber No. 23, Taber No. 129, Yeddoichi, Yemon, Zengi.

The amount of dark flesh found in fruits of varieties of the group *Pollination Variants* depends both upon the number of seeds and upon their location with reference to one another. Referring to cross sections of fruits of the *Pollination Variants*, it will be noted that when only one seed is present the whole area is not darkened and the seed roughly forms the center of the darkened area which may be more or less interrupted by the gelatine-like development of the walls of the empty locules included within the circle. If two seeds are present in adjoining locules, it will be noted that while the area is increased and in some cases shows darker owing to the overlapping of the affected areas, yet the whole area in cross section is not darkened. If two seeds are present, diametrically opposite one another, the whole area, if not too great, may be darkened. Three or four seeds properly located are usually accompanied by an entire darkening of the surface. In large specimens of Yemon, this is sometimes not the case and occasionally specimens may be found with nearly or quite the full complement of seeds which show a narrow light band just inside the skin, while the remainder is all darkened.

In fruits of both Hyakume and Yemon, it appears to require the development of a larger number of seeds to darken the entire area than is the case with smaller varieties such as



THE EFFECT OF TWO SEEDS.

The variety shown is again Zengi, also figured in the two preceding illustrations. The development of two seeds in this variety (a "Pollination Variant") darkens a large part, but not all, of the flesh. (Fig. 8.)

Zengi and Taber No. 129. Whether this is merely a question of size or whether it is a peculiarity into which size does not enter, is not known. The presence of seeds in Okame is accompanied by the darkening of small areas about them; no such general effect upon the flesh has been noted as is the case with Hyakume and some other sorts.

Associated with the changes in the color of the flesh there are well marked variations in time of ripening, shape and size of fruits, quality and texture of flesh, but as these associated variations have been covered in detail elsewhere,[4] they need not be dwelt on here.

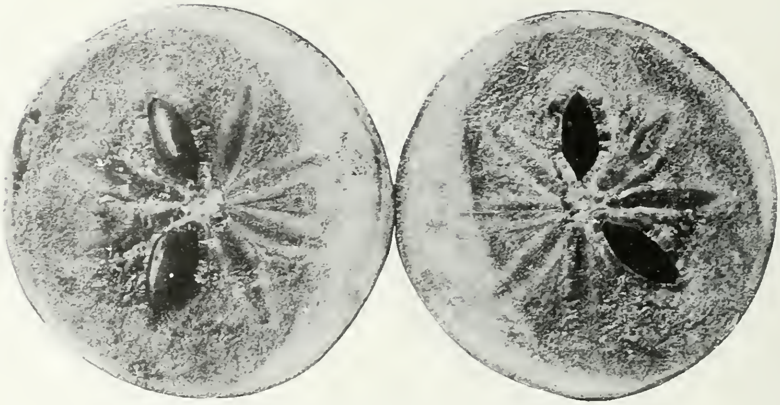
OTHER SPECIES.

In connection with the behavior of fruits of other species of *Diospyros* it may be of interest to point out that there appear to be two distinct strains of *D. lotus*, one with dark flesh, the other with light flesh. The fruits of *D. virginiana* are always light fleshed, the fruits of *D. texana* are always dark fleshed.

Why is it that *D. kaki* presents these peculiar characteristics? Why is it for instance that Tsuru is always light fleshed whether the fruit contains seeds or not, while Yemon is light fleshed when seedless and dark fleshed when seedy? Is it not likely that *D. kaki* is not a true species but rather a mixture of two or more species, hybridized and grown under cultivation for centuries? Is it not possible that the present cultivated varieties known under the name *D. kaki* are derived from two distinct species, one bearing dark fleshed fruit and the other light fleshed fruit? Is the dark fleshed character latent in the *Pollination Constants*?

While the answers to the questions indicated may never be definitely known and it may be that the phenomenon of flesh color changes is due to entirely different causes than those suggested, yet the fact remains that *D. kaki* under cultivation presents wide variations in many particulars, and the suggestion that it is a conglomerate species is at least a plausible one. In shape and peculiarities of fruit, color and characteristics of bark, size and shape of leaves, habit of growth and size of tree, they vary much more than any of our common fruits usually regarded as being derived from single species. The problem is a complex one. Some light might be thrown on it by a careful exploration of Japan and the adjacent mainland of China. Since the Japanese forms had their origin in China a care-

[4] Hume, H. Harold. Effect of Pollination on the fruit of Diospyros Kaki. Proceedings of The Society for Horticultural Science. 1913—pp. 88–93. Mar. 1914.



WHEN THE TWO SEEDS ARE SEPARATED.

It was shown in the preceding illustration that the development of two seeds was not sufficient to darken the whole area of the flesh of this variety (Zengi) of *Diospyros kaki*, the Japanese persimmon. Comparison with Fig. 8 will show that more of the flesh is darkened when the two developed seeds are nearly or quite opposite, than when they are side by side. (Fig. 9.)

ful survey of this whole region might do much toward clearing up many obscure features in the behavior of *D. kaki*.

All the varieties introduced by Frank N. Meyer. Agricultural Explorer of the United States Department of Agriculture, in 1905 from northern China belong to the group of *Pollination Constants*. It is probable that no other kinds are to be found in the sections which he visited. Elsewhere in China varieties belonging to the group of *Pollination Variants* may be found and it may not be an entirely wild surmise to suggest the existence of a persimmon region where dark fleshed *Pollination Constants* are to be found. It must be borne in mind that *D. kaki* is not native to Japan, but is an introduction from China. Since the Japanese introductions were made several centuries ago, no doubt the two groups have diverged greatly, even granting they were originally one.

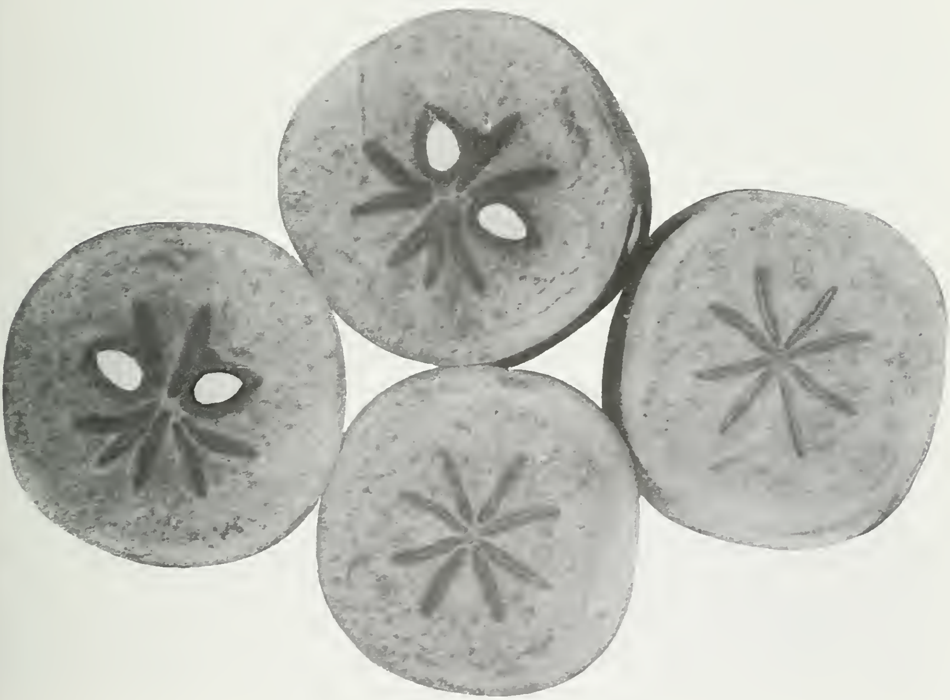
THE FLOWERING HABIT.

One of the interesting things in connection with *D. kaki* is that, as already pointed out,[5] certain varieties bear both staminate and pistillate flowers. Some of those which bear staminate flowers do so regularly every time the tree blooms, while other varieties produce them one season and not another, in fact are very irregular in this particular. The first class of staminate trees we have designated as *Staminate Constants*, while the second class of staminate trees may be called *Staminate Sporadics*. Those which produce only pistillate flowers may be referred to as *Pistillate Constants*. It is interesting to note that staminate flowering varieties of both classes are much more commonly found among the *Pollination Variants* than among the *Pollination Constants*. In the former group, there are now known to be at least five varieties which either constantly or occasionally produce flowers with pollen. These are Gailey, Masugata, Okame, Taber No. 23, and Taber No. 129. Among the *Pollination Constants* only two staminate flowering sorts, viz: New Sien and Siang have so far been found. It is not improbable that they belong to a different species from the other varieties or at least a different section of *D. kaki*. These two varieties are both recent acquisitions, belonging to the collection, already referred to, secured in China by Frank N. Meyer.

[5] Journal of Heredity, Vol. V., No. 3. March 131–138. 1914.

ALL THE FLESH DARKENED.

The normal complement of seeds in the Kaki is eight. When this variety (Zengi) develops seven (or eight) seeds, all its flesh is darkened; while, as has been shown in the previous illustrations, the development of a smaller number of seeds darkens only part of the flesh, which is altogether light-colored if the fruit develops no seeds at all. Zengi is, therefore, a type of the Pollination Variant class. (Fig. 10.)



A POLLINATION CONSTANT.

The variety Tsuru, here shown, behaves quite differently from Zengi, when pollinated. Its flesh is normally light in color, and the presence or absence of seeds has no effect on this color. Tsuru, therefore, undoubtedly falls in the class of Pollination Constants. Why should there be two groups of varieties in the species *Diospyros kaki*, behaving so differently when pollinated? Mr. Hume thinks it may be that they are really distinct species, which have become united under cultivation. (Fig. 11.)

The different varieties so far studied may be grouped on the flowering habit as follows:

Pistillate Constants. Group I.

Tanenashi, Hachiya, Costata, Tsuru, Tamopan, Hyakume, Yemon, Yeddoichi, Phelps, Triumph, Zengi.

Staminate Constants. Group II.

Gailey, and probably Masugata, Siang (S. P. I. No. 21910) and (S. P. I. No. 27037).

Staminate Sporadics. Group III.

Okame, Taber No. 23, Taber No. 129.

It is of course impossible to determine the flowering habit of any variety until it has been under observation for a number of years. If a variety, represented by a considerable number of specimens, has been constant in its behavior for at least five successive years, its habit may be judged with fair accuracy. This is the basis on which the varieties named have been assigned to the last two groups.

It may be possible to select strains of *Staminate Sporadics* that will be so constant in their behavior as to entitle them to a place among the *Staminate Constants.* An attempt in this direction with Taber No. 23 has met with some measure of success. In the winter of 1910 a staminate twig of this sporadic was grafted in the top of a large *D. virginiana* seedling. In the spring of 1912 the branch developed from this graft bore a goodly number of staminate flowers. In 1913 and 1914 it likewise bore staminate flowers, as well as pistillate ones. The second graft generation started in 1913 has not bloomed yet.

A NEW OAK FOR BREEDERS

WITH the increase of interest in nut-bearing trees, among plant breeders, and particularly in view of the growing interest in oaks, attention may well be called to what is probably the largest known acorn, shown in the accompanying illustration, and produced by *Quercus insignis*, the "noteworthy oak," a species discovered in the state of Vera Cruz, Mexico, by the Belgian botanist Galeotti, and described by him jointly with Martens in the Bulletin of the Academy of Brussels, X, II (1843) 219.

The tree is rapid in growth, and quite different in habit from most oaks. It reaches an ultimate height of 60 to 80 feet or more, is quite erect, and sends out large branches at the height of 30 or 40 feet from the ground. It is found in considerable abundance about midway down the flanks of Mount Orizaba, being most common about Chiapas, according to Dr. C. A. Purpus, who has recently been collecting in that region. It is a white oak, maturing its fruit the first season; and being a white oak, its fruit has sufficient edible quality to be available at least for stock food.

"The only other oaks that approximate it in size," according to Dr. William Trelease of the University of Illinois, who called the attention of this association to the species, "are a close relative, *Quercus strombocarpa*, of the same region, and a Guatemalan black oak, *Q. skinneri*—the latter apparently an equally large tree, and with acorns two inches in diameter but presumably bitter or astringent like our own black oak acorns."

The nuts of *Quercus insignis* are usually about two inches in diameter, but may reach two and one-half inches. Their weight is from 50 to 65 grams each.

In view of its range, the tree is naturally to be supposed unsuited to a temperate climate, but Dr. Purpus writes, "I think it a very useful tree which could be raised in Florida, Cuba, Porto Rico, etc." The Office of Foreign Seed and Plant Introduction of the U. S. Department of Agriculture is now endeavoring to introduce it to those regions on a large enough scale to give it a chance of success. If it is found to be well adapted, it is possible that native species of oaks could in some cases be grafted over with the more productive new one, thus yielding a large crop of acorns with very little trouble or care. Hybridizing experiments should also be tried with some of the best North American oaks, with a view to seeing whether the size of their acorns can not be increased.

ACORNS OF QUERCUS INSIGNIS.

They are photographed (natural size) with acorns of *Q. coccinea*, the Scarlet Oak of the Eastern United States, for comparison. *Quercus insignis* is a white oak found on the slopes of Mount Orizaba, in southern Mexico, and probably produces larger nuts than any other oak in the world. It offers interesting possibilities of introduction to other tropical regions, and also breeders in more temperate climates. The material from which this photograph was made was kindly sent by Dr. C. A. Purpus, Zacuapan, Huatusco, Vera Cruz, Mexio. (Fig. 12.)

EUGENICS vs. CACOGENICS

An Ethical Question of Importance to the Movement—Attention Should Be Centered on Factors of Absolute Value, Not on Those of Merely Relative Value.[1]

Dr. E. E. Southard,

Member of the Board of Scientific Directors of the Eugenics Record Office; Director of the State Hospital, Boston, Mass.

ABSTRACT.

The attitude of social workers to eugenics.
The attitude of plant and animal breeders.
Eugenics and utilitarianism,—
of the egoistic form;
of the altruistic form.
Eugenics and Malthusianism.
Evolutionistic or developmental ethics and eugenics.
Interracial difficulties solved by racial development.
"Relative" or "view-point" eugenics, *i. e.*, eugenics for Race A is cacogenics for Race B, and *vice versa*.
Possibility of defining "absolute" as opposed to "relative" eugenics.
Two conceptions of absolute eugenics:
(a) a metric conception, in which eugenic conditions range by degrees from the worst (*cakisto*) through bad (*caco*) to good (*eu*) up to the best (*aristogenic*) conditions:
(b) a conception in terms of *survival-values*, in which eugenic conditions would depend on germ-plasm tendencies to improvement, deterioration, or death for intrinsic or extrinsic reasons.
Examples of absolute cacogenic factors, logically possible though not yet thoroughly demonstrated:
(1) germ-plasm senescence.
(2) gametes prepotently poisonous to the zygote.
(3) gametes themselves altered, *e.g.*, by alcohol or syphilis.

EUGENICS, as the science of improving man through his heredity, is now in its thirtieth year and, as a name and propaganda, is already becoming known to a new generation, unbiased by the splendid personality of its founder and no longer moved by the early prejudice of those who pigeonholed eugenics with socialistic, paternalistic, or Utopian programs, with a philosophy of prudential (rather than emotional) marriages, with free love tenets, or with a plan to debase man by showing him subject to the same laws as plants and animals. Accordingly, eugenics is being taken more on its merits. Despite bitter logical quarrels (or even in consequence of these) over the scope of the statistical (biometric) and the intensively analytical (Mendelian) methods in the general field, the term eugenics has been adopted by both sides to these controversies, and those controversies themselves have come to be regarded as questions of technique rather than of aim.

The new generation is taking stock of eugenics in the light of new and wider views of social service, and of preventive

[1] Presidential address delivered before the Eugenics Section of the American Breeders' Association at the ninth annual meeting, in Columbia, South Carolina, January 24, 1913; being contribution from State Board of Insanity, Massachusetts, Number 21 (1914.1). (*Bibliographical note*. The previous S. B. I. Contribution Number 20 (1913.20) was by L. Vernon Briggs, entitled "Three Months without and Three Months with a Social Worker in the Mental Clinic at the Boston Dispensary").

medicine. We accept now as guidance what we formerly regarded as interference and are welcoming as supervision what we should decline as control. Not even yet are we ready, in America at all events, to submit such matters to legislation. My friend and colleague, Professor Minot, has long insisted that we begin to die at birth or before. It it certainly true that laws often begin to lose their effect upon their passage and that the most effective laws, at least of the North-European races, are unwritten. Accordingly, it seems best to agree with those who fear the effects of social legislation. Social legislation is likely to be hasty, premature, superficial, partial, trimming; it is apt to be born of partisan or sectarian compromise; and it rarely takes account of the future.

The unwritten laws of public opinion may be subject to many of the abovementioned charges; but they are at least not in the hands of the lawyers.

In whose hands are these unwritten laws? I find that social workers in general, certain workers in every important religious sect, physicians and hygienists, are the most ardent seekers for knowledge in these fields. This is especially true of eugenics, which has come to take its place alongside charities and correction, sex education, the alcohol problem, mental hygiene, control of tuberculosis, child labor, and the like, as a worthy competitior for social attention.

THE PLACE OF EUGENICS.

It requires a somewhat larger purview to ascribe to eugenics its rightful place. Logically taken, eugenics is not quite such an elaboration of the obvious as, *e.g.*, the antituberculosis program. It is at first sight a curious fact that the members of the American Breeders' Association should catch the point of eugenics earlier than many high-minded social workers who are working in this country to improve the environment of man, himself regarded as an entity varying with the environment. Not a plant or animal breeder of this association but is equally persuaded of the value of altering environment, of which he sees the most convincing examples every season; but the value of pedigreed livestock and of special breeds of plants is so obvious to the breeder that I doubt if he would understand the hesitancy of the urban world of social and allied service to adopt the commonplaces of the breeder's philosophy.

But, judging from the flood of popular books and articles on eugenics, I take it that the urban world of social service is fast waking to an interest which will one day take its proper place.

But are plant breeders and animal breeders more likely than social workers to evaluate the ethical motives and aims of eugenics? What are the motives and aims of eugenics? We shall find a number of more or less divergent accounts.

I suppose that the British origin of the movement and its following upon the wave of utilitarian ethics which came to expression in Britain in the earlier years of the nineteenth century (though intimations are plain so far back as Hobbes) would lead many to the belief that eugenics is above all prudential. Is it not perhaps subject to the fallacy of adding cubits by taking thought?

The telling arguments of Galton, the graphic presentations of Pearson, the claims of still more precise analysis by the Mendelians, all savor of the intellectual. They are intended to convince rather than persuade. They often do convince without persuading.

Doubtless no enumeration of ethical systems can be complete, especially now that everybody is well aware that manners change with the times. Setting aside the various political and religious systems of ethics as embodying in various particular forms the more fundamental human tendencies, we may divide with Wundt the ethical systems of man into two main groups.

The eudaemonistic or utilitarian group of ethical theories is surprisingly British in its origin and continual display. The names of Hobbes, Locke, Hume, Hartley, Bentham, Mill, are prominent in its history. The more

hard-headed form of utilitarianism preached that *altruism results from selfish considerations*. Or Hume might describe an *objective sympathy*, due to laws of mental association.

EUGENICS NOT EGOISTIC.

But eugenics from an ethical viewpoint must soon traverse these hard-headed and essentially egoistic forms of utilitarianism. Eugenics, whatever else it may be, is surely transindividual in its scope. To be sure, the eugenist may dwell with pride upon "my" progeny, family, nation, or race, and the motive in eugenic policy may remain as utilitarian as ever.

Still there would be no denial that the common-welfare ethics is in some sense superior to the egoistic forms of utilitarianism. And eugenics, if it can be appraised in utilitarian terms, must surely be described as transindividual and altruistic. If the inborn qualities of the race are by hypothesis to be somehow improved, then it is obvious that the race must be preserved and doubtless in proper numbers. Leaving out of consideration for a moment just what proper numbers mean, it is clear that eugenics is not merely Malthusianism. Nor has eugenics, so far as I can see, any necessary connection with Malthusian considerations or with population-numbers. The emphasis is no longer upon quantity, but upon quality of people, and upon their quality regardless of their numbers. Doubtless Bentham's phrase "*the greatest good to the greatest number*" as the great utilitarian object, would perfectly suit one interpretation of eugenics, provided that we simply qualify the *greatest number* by insisting that their *inborn qualities* be somehow improved. Thus eugenics is not at all inconsistent with those higher forms of British utilitarianism which insist on improvements looking to the common welfare. Grant the eugenist's claim that the best should marry and grant that science can show who the best are, and it is obvious that the limitation of child-births to a marriage is not in the interests of the race. No eugenist, therefore, is rationally an advocate of race-suicide. His special task is to show that, and how, the inborn qualities of the race can be improved. The improvements which better men will make in their accessible environments will, the utilitarian might well argue, automatically put an end to the tendency, now thought prevalent, to the prudential limitation of child-births.

The most successful eugenics conceivable (*aristogenics*), issuing from a process by which *more and greater great men* would continually be produced, should gradually put an end to comparatively minor problems of civilization like the Malthusian problem.

But to my mind such discussion is a little over-rational to be quite persuasive. It is doutful whether the utilitarians are the soundest moralists, whether pleasure or even happiness are more than merely phases of our endeavor to greater realization either of self or of some larger social unit like the family, state, or race.

UNIVERSALITY OF EUGENICS.

The evolutionistic theories of ethics (as Wundt terms them) in contradistinction to the utilitarian theories, (which he terms eudaemonistic) are usually distinguished into individual and universal forms. As before, we must obviously regard eugenics, if it be an ethics of development rather than of happiness, still as rather transindividual, rather universal than individual.

But, though eugenics is surely transindividual, it is not so clear that all authors regard it as a program for the human race as a whole.

I can conceive a tacit hope that British eugenics might tower over German eugenics, or that Teuton eugenics should excel various other Caucasian forms. How shall eugenics for the Caucasian be consistent with that for the Semitic races? And so on.

It would clearly be hard to solve such problems by the utilitarian devices. The utilitarian, however, hardly takes into account the degree of change which his material undergoes in the course of time. Of course the present-day lion

does not remain alongside the present-day lamb; but there is no accounting for the lions and lambs of a future age. Even the demand for horses—at all events good horses—is said to have risen since the advent of the automobile.

With the perfection of civilization there is no reason to suppose that the very terms of those problems will not themselves change. In all these social equations the unknown X, of improvement in inborn race quality, may come to the rescue of the solver.

In this way—that of the ethics of development, in accordance with which the terms of equations and the equations themselves vary in the course of time—I try to solve for myself the at first sight perplexing problem of the conflicts of eugenic ideals among races of a given day and generation. I am thus loth to admit that the eugenics of the one race is the cacogenics of the other. To state this is to commit oneself to a kind of utilitarianism which is not far removed from the egoistic kind; for it makes one's nation as it were one's self, and devil take the rest. Whereas a part of the eugenic program should be to produce people insusceptible to prejudice, even of that pleasurable type known as race-prejudice.

EUGENICS VS. CACOGENICS.

The essential relativity of the several eugenic ideals—is not this the disappointing result of the present train of thought? Is not the eugenics of one race the cacogenics of the other? Must we not choose arbitrarily, though as wisely as knowledge permits, the particular eugenic ideal and work therefor? That, we must! But let us not forget that the material changes under our hands and that continual revision will be necessary.

I gather that animal breeders have hardly revised their genetic ideals for many years and that new breeds are now seldom developed. The plant breeders on the other hand are stated to be in process of producing new and valuable breeds at a greater rate. But both these genetic fields are far more under the control of the race than the eugenesis of the race itself.

I am disposed to deny that eugenics and cacogenics are purely complementary terms. I am disposed rather to conceive that the relation between the two is a relation such as obtains between health and disease. No one can choose between health and disease as one may choose breeding for milk and breeding for beef; breeding for speed and breeding for endurance; breeding for proteid and breeding for starch; etc. It is clear that fast horses are no better than hardy horses except for given purposes, and the choice in breeding is made on economic rather than ethical grounds.

But breeding plants or animals which shall be innately immune to certain parasites is a process approaching, on a low level, an ethical process. In this case we save something (on other grounds considered worth saving) from parasites which would otherwise terminate the existence of the things worth saving. The economic or low-level moral judgment involved in the decision "*worth saving*" is as relative as you please to various economic or higher aims, and of course the decision has a bearing on the parasite's worth.

But all this relativity of the data on which we decide to save has nothing to do with the morbidity and mortality of the species attacked. There are morbid processes leading to species-destruction. Hereditary factors of susceptibility and of lowered resistance may possibly be in play.

These hereditary factors of morbidity and mortality which come into play in a given species are in so far cacogenic factors. They lead to deterioration, or destruction, not merely of the individual, but of the race.

Eugenic rearrangements of germ-plasm, eugenic networks of descent, could conceivably still occur in a golden age in which cacogenic factors would be absent, just as hygiene might still have various tasks to perform in a golden age without disease. Such millennial eugenics would consist in *more or less good* genetic arrangements, with

aristogenics tending to perfection as a limit.

But, as actual disease introduces new factors and new duties into hygiene, so are essentially deteriorating factors introduced into eugenics. It should be our task to determine the nature of these factors of what may be termed absolute cacogenics as distinguished from relative cacogenics.

Relative eugenics—the sort which might, *e.g.*, insist that the eugenics of the white race is the cacogenics of the black race—is of far less theoretical interest than *absolute eugenics*—the sort which might seek the amelioration of the whole human race by hereditary factors. In my capacity as a loyal son of Japhet, I might, as interested in the relative eugenics of the C ucasian, desire the extermination of the black race, and any hereditary factor which would tend to the black's survival I should regard as cacogenic for the Caucasian. Obviously, however, the son of Ham can fairly assert the same philosophy, and Caucasian cacogenics could be legitimately termed, by the Ethiops, Ethiopian eugenics.

THE VIEW-POINT.

Herein we discuss to no more purpose than with regard to the relative merits of breeding for milk or breeding for beef. Nor have we the recourse of referring to our bank-accounts as in the milk versus beef problem.

What the theorist of relative eugenics is reduced to is the identification of eugenics and cacogenics and the definition of each according to some point of view. To me such eugenics of the view-point is unsatisfactory, if not revolting. The "view-point" or "relative" eugenist of British race has really no answer to the German who might say that Galtonian eugenics is nothing but a prudential onslaught on Germany, an endeavor to meet the German war-policy. Naturally nothing was more remote from Galton's mind, albeit I do not doubt he was a loyal Englishman and desired his race to excel.

No! British eugenics is not German cacogenics, and German eugenics is not British cacogenics! Rather must the improvement of the inborn qualities of both races proceed to such a point that the peace of Europe can never be threatened. Let the improvement of the races proceed as much in the twentieth century as in the nineteenth, and the peace of Europe might never be threatened. Perhaps all we need is another Faraday, another Helmholtz, another Darwin, and another Pasteur. Four gifts like these do not seem overmuch to ask, since the world is in the habit of receiving them. To be sure in the cases of Faraday and Pasteur, there are no available hereditary data which prove that they are aristogenic products. And the case of Helmholtz is not so good as that of Darwin for the aristogenic proof. Yet think how young is the form of investigation which could bring that proof. And eugenics remains civilization's best technique for transforming itself through the works of great men. Or shall we just wait for something to turn up?

Is there then any legitimate field for a logically sound cacogenics? Alas! yes. There is, I believe, a sense in which cacogenics is not a relative term, not merely a term to express that what is meat for one is poison for another. Absolute cacogenics is a kind of pathological eugenics. The cacogenic is not merely the less eugenic, any more than the morbid is the less healthy. Just as there are in some sense degrees of health, so there are in some sense degrees of disease:—but it would be rash to say that the two scales of health and disease could be set end to end and so polarized that the least degree of disease would just precede the least degree of health.

NO CONTINUITY.

We spoke above of golden age eugenics as capable of a *more or less*, even if cacogenic factors were by hypothesis absent:—but who would suppose that, beginning (a) with the worst cacogenics (let us say *cakistogenics*) and rising in the scale (b) to the least and faintest cacogenics, we shall then slide over (c) into the least eugenics and finally

emerge (d) with the most developed eugenics of all (*aristogenics*)?

I have naturally no time here to develope a thesis concerning the respective natures of health and disease. Some years ago, under the guidance of my friend Professor Royce, I tried to clear up, for myself at least, this peculiar problem that had so long faced me as a pathologist, what is the essential nature of disease? To put the results briefly, I concluded that the statistical or metric conception of disease—the conception which contrasts the normal with the subnormal, supernormal, or abnormal—was not the only or perhaps the most valuable conception of disease. The pathometric branch of biology was not, I concluded, the only kind of pathology. To be sure, pathometry yielded important data and aided in establishing important norms of magnitude, shape, color, consistence, of organs, as well as graphs of their functions. And, no doubt also, it was often true that the abnormal happened at the same time to be the morbid and that the anomaly constituted a disease in some still more persuasive sense.

As against pathometry or the measuring kind of pathology, there was another kind of pathology interested in the survival or destruction of cells, cell-organs, and their functions. There was a kind of pathology interested in the life and death of organoids, cells, cell-complexes, tissues, organs, and the organism, as well as in the preservation or termination of their functions. There was a pathology not so much interested in the *more-or-less* as in the *all-or-nothing* of living units and processes. It is hard to find a term for this pathology of *outcome* instead of graduation, of *survival* rather than amount of protoplasm. Perhaps it may be provisionally termed *necrobiotics*, revamping a term often used in descriptive cellular pathology for a tissue containing both dead and living elements.

Hurrying by the vast undefined landscapes which these words bring into view, I wish to suggest that there is probably a kind of cacogenics which does *not* signify mere difference of point of view (as good beef-cattle might be cacogenic products for one who was breeding milch-cows) and again does *not* merely signify a less eugenic product (as talent fades beside genius), but rather is a science descriptive of *ways in which man is* (not improved but) *deteriorated* (not through environment but) *through heredity*.

Suppose some one could prove senescence to be a process going on in the germ-plasm, as we see it go on in the somatic tissues, so that the race was gradually to decline or cataclysmically to cease. Here would be an absolutely cacogenic factor.

Or suppose some one could show that special properties in one gamete could propotently poison the zygote, so that Mendelian percentages and Galtonian tendencies would alike be abolished, whenever that gametic strain was united with another. I have sometimes thought that such might be the case with the germ-plasm of certain feeble-minded subjects, since upon their union with apparent normals, feeble-minded progeny were produced in alarming disproportion.

Of course, too, it is clear that disease may alter, not merely the soma, but also the germ-plasm. It is not clear but that characters acquired by the germ-plasm may be inherited, although I suppose the principle needs proof. It often seems to the alienist that alcoholism and especially syphilis may well be guilty of such cacogenic modifications of the sex-cells.

SUMMARY.

1. The eugenics propaganda presents ethical difficulty in view of our ignorance not merely *how* to breed better men, but actually *what* improvement or improvements we seek.

2. The plant and animal breeders know what they are breeding towards, and hence face problems of technique only; the eugenist, it may be feared, does not know to what he ought to breed (unless we are content with generalities like "citizenship" or "brain-power")

3. The British origin and historical setting of the eugenics movement suggest that eugenics is an outcome in one sense of British utilitarianism, although there are certainly no Malthusian or race-suicide components in the theory.

4. The chances are that the ethical basis of eugenics lies more in the evolutionistic than in any utilitarian doctrines and that, just as an ethics of self-development is superior to an ethics of happiness-seeking, so an ethics of race-development is superior to an ethics of the greatest good to the greatest number (at least if *good* be defined as anything short of full development).

5. At all events the warning deserves utterance that no narrow nationalistic or chauvinistic interpretation of the eugenic aim should be allowed to prevail, as for example that British eugenics is German cacogenics and *vice versa*. The eugenic evolution should rather be to develop each nation to the death-point of national prejudice and to the maximal vitality of coöperation.

6. To clarify this ethical situation, certain distinctions need to be drawn: both in the matter of eugenics and in that of cacogenics it is proper to distinguish a relative from an absolute form.

7. Thus the breeder of draught-horses might consider speed-producing factors as interfering with his plans, as relatively cacogenic, whereas he might well acknowledge that another breeder would find such factors relatively eugenic and draught-horse factors relatively cacogenic: similarly, should the white race go down in its heredity, Caucasian cacogenics might prove Semitic or Ethiopian eugenics, but always in the relative sense of these terms.

8. It would accordingly be wiser to consider the problem of eugenics in the absolute sense within the species. Cacogenic factors in human progress would not be merely factors which for arbitrary reasons are considered proper to exclude, as for example, short men, with prognathous jaws, etc: for here the cacogenics would be merely relative.

9. What we must study to avoid are the absolutely cacogenic factors, such as pathology in its widest sense might discover. Examples of such absolutely cacogenic factors are:

(a) possible senescence (not in somatic cells only but) in the germ-plasm itself;
(b) possible prepotently toxic powers in a gamete, such that all zygotes in which such gamete was a component would produce morbid individuals out of all theoretical proportions;
(c) possible inheritance of qualities acquired (not by the somatic cells but) by the germ-plasm (*e.g.*, through alcoholism, syphilis).

10. This contrast between relative cacogenics and absolute cacogenics reminds one of the contrast between the pathology of measurements and anomalies and the pathology of survival-values for cells, organs and the organism.

11. It may well be that the pathology of survival-values is theoretically reducible to a metric basis and that these survival-values can be put on a "more-or-less" rather than on an "all-or-nothing" basis: There is nevertheless an important sense in which the pathology of anomalies is distinct from that of life and death.

12. Accordingly, I propose that the logical technique of pathology be applied to the problems of absolute cacogenics, such problems as those mentioned in paragraph 9 above, to the end that more may be understood as to the essential pathology of the germ-plasm.

The Human Breed.

To be a good animal is the first requisite to success in life, and to be a nation of good animals is the first condition of national prosperity.—Herbert Spencer.

Men are commonly more careful of the breed of their horses and dogs than of their children.—William Penn.

AMATEUR ROSE BREEDING

Necessary Operations Easily Performed, and Results Certain to be Interesting, Even if Failures are More Numerous Than Successes—Practical Rules and Hints—How Famous Roses Have Been Produced.[1]

VIVIAND-MOREL, *Editor of Lyon Horticole, Lyon, France.*

THERE are few more agreeable occupations for an amateur, and few more profitable for a professional, in horticulture, viticulture or agriculture, than that of creating new varieties of flowers, vegetables, cereals and fruits, which shall be more productive and more beautiful than those now found in our gardens, orchards, vineyards and fields.

This occupation is within reach of all who have a little—a very little—spare time, and who are endowed with continuity of thought.

For professionals who desire to make a commercial enterprise of plant-breeding, there is one primary difficulty: they must know the varieties, the races, the sports already in the trade, of the genera which they undertake to improve.

If they ignore that detail they risk trying to break in doors that are already wide open, as the saying goes, and what they produce is likely to be an old story. It is only in the case of really sensational acquisitions that one may dispense with a knowledge of what is already in the trade. It is certain that if a horticulturist secured a blue rose, a blue dahlia, a blue carnation, he would not have to worry about the work of his predecessors or contemporaries. If the color existed in those flowers, it would be known. It has been sought long enough.

It is desirable, when undertaking to secure new varieties, that one specialize in some particular genus. That is the way followed by a great many of the most successful horticulturists, viticulturists, and agriculturists.

One might take up roses, various shrubs, gladioli, petunias, verbenas, carnations, salvias, etc., or peas, beans, beets, carrots and other vegetables. In agriculture the wheats, oats, barley, rye, the clovers and alfalfas could furnish remunerative work. This enumeration will suffice to indicate how vast is the field for exploration. As no one is expected to know everything, the breeder should direct his studies to the side which seems to him the most agreeable, the most profitable and, at the beginning, the easiest.

SOME TECHNICAL TERMS.

In undertaking to breed new varieties of plants, it is useful to become familiar with certain terms employed by professionals, which are constantly found in works that treat of these questions, or that will constantly be heard in conversation. Such, for example, are the words genus, species, variety, race, hybrid, cross, atavism, selection, segregation and some others. I shall summarily indicate what we mean in using these words in horticulture.

Genus.—This word has a good many different significations in French, but in botany it is applied to a group of species which differ in some of their characteristics, but which can be grouped together, for the purpose of facilitating study, because they possess certain other characteristics in common. Example: the rose is a genus which includes a great many species; the gladioli, petunias, heliotropes, clovers, alfalfas, peaches, plums, etc., are genera.

But all authors are not in accord on the definition of a genus. Formerly cherries and apricots were in the plum (Prunus) genus, and the apples in the pear (Pyrus) genus. Many similar

[1] Translated from Lyon Horticole.

examples might be cited. Anyhow, the genus is of secondary importance in genetics.

Species.—A substantive whose definition is much disputed. It may be compared with that of a genus. If genus is a word which serves to group a number of species, species is a word which unites the varieties, races and variations of the same type.[2] Today we distinguish systematic species and elementary species. The first (also known as Linnaean species or type species) are described in most of the classical Floras and works of botany. The second, which are subdivisions of the first, are also called Jourdan's species, elementary species, etc. To make a long matter short, let us say that they are races which reproduce true from seeds.

Hybrids.—Products of crossing two systematic species.

Crosses.—Products of crossing two races or varieties of the same systematic species, or of crossing descendants of hybrids.

Atavism (or Reversion).—A return of crosses or hybrids to the characters of their ancestors.

Segregation and Selection.—These are two nouns employed by genetists which generally pass for synonyms. Nevertheless they have different meanings which should be known by everyone who takes an interest in seeking new races of plants.

NATURAL SELECTION.

Segregation is a French word used as early as the sixteenth century to represent the action by which one sets apart or separates from the whole, from a mass, one or several objects which are different from it. Selection is a word first employed by English breeders to signify the choice for breeding of animals endowed with the characters which the breeder desires to fix in a distinct variety of animals. Taken in this sense, selection has the meaning of marriage, if I dare to use the word, between well-matched individuals. Selection passed from English into the French language where it became popularized through the phrase natural selection, invented by Charles Darwin. According to the famous English scientist, natural selection refers to the predominance which nature yields to any given species or variety, because of the greater adaptation of its characteristics to those of the environment, as regards nutrition, conservation, reproduction, etc.—an adaption which allows it to persist and brings about the disappearance of less-favorably endowed species which are unable to compete with it.

In horticultural practice, selection signifies the choice of particular subjects noticed among seedlings: extraordinarly large or small specimens, particularly early or late individuals, etc. As for trees, one can often practice selection on a single tree or shrub, selecting branches which are more fertile, precocious, late vigorous, etc., than others.

Pedigree culture or genealogical culture.—In this mode of cultivation, one must start with seeds furnished by a single individual, and must follow its descendants for a number of generations to make sure that it is fixed. If it is variable, the study of its variations should be pursued until it is decided that they are not going to furnish the desired results.

Other technical words used in plant breeding will be explained as they are employed in the course of this study. As I have promised a number of persons to discuss roses, I will now keep that promise by giving some practical directions for rose breeding to amateurs.

SELECTION OF BRANCHES.

I note in *La Petite Revue* a report of the exposition held at Antibes, on the French Riviera, last March, in which M. J. Lefevre makes the following comment which bears, in part at least, of the selection of branches:

"In a very different way, M. Dhumez was able to get from Nature more than she had ever wanted to give. Disre-

[2] The lay reader will probably be less confused if he retains the old definition, that a species is a group of organisms which interbreed freely.—The Editor.

PREPARING TO POLLINATE.

At the right an unopened rosebud is shown. Roses must be pollinated at this stage; if they are allowed to open before being worked, the bees are likely to interfere. The center shows the bud with sepals and petals removed, disclosing the stamens or bearers of pollen, surrounding the ovary. At the left, the ovary alone is shown, the stamens having been removed with a small pair of forceps or scissors. The bud at the left is ready *to be* pollinated, by the application to its sticky top of stamens cut from some other rose. (Fig. 13.)

garding the field of selection of seedling variations, and confining himself to varieties which he had bought in the open market—some of them little known, such as Prince de Bulgarie, and others long since used by everyone, some of them for a long time past, such as Bastide rose—M. Dhumez was able, by *a very sure selection*, a judicious choice of fertilizers and, especially, of method of operation, to get such remarkable results that they would have been declared impossible: the size of the flowers, the absolute perfection of form and color of Prince de Bulgarie, Marquise de Mores, Agathe Nabonnand, Agathos and others, won as soon as they appeared not only the rapt astonishment of the public, but the highly-valued admiration of experts."

Here, then, is a grower who by *a very sure selection* and by other artifices of culture, was able to present well-known roses—and also the variety Prince de Bulgarie, less known—which called forth the rapt astonishment of the public and the admiration of experts.

Perhaps it will be said that the manuring and the cultural methods played a greater part than selection in M. Dhumez' success. Furthermore, one may say that his success is doubtless only momentary, incapable of reproduction by grafting, budding or marcottage. All that is possible, but the contrary is also possible. This is the reason:

Every rose grower knows that the varieties called Climbing Roses by the English are varieties whose mothers

were not procumbent by nature, and that such varieties can be produced almost to order, by taking scions from branches which show a tendency to extend. Such extension can be provoked by pruning, manuring, and especially by a shady location.

PRODUCING BUSH ROSES.

Bush roses can be produced in the same way that climbing roses are, from bushes of ordinary height. It is only necessary to cut your grafting wood in the neighborhood of the inflorescences. The procedure is well known for the Noisette Aimée Vibert. It is perhaps too well known. In attempting to procure the old, giant type I twice secured the dwarf.

I remember having seen at a rose exposition some specimens of Noisette William Allen Richardson, cultivated in pots and relatively dwarf of height, well covered with flowers; they were exhibited by M. Patichoud, a horticulturist at Lyon-Croix-Rousse. Had he practiced selection of grafting wood on the specimens of this remarkable variety obtained from Mme. Veuve Ducher? There seems to be nothing to contradict such a belief.

It seems probable, too, that many beautiful procumbent or Sarmentose varieties which have cast a bright light in the firmament of roses and then have disappeared from view, have vanished from rose gardens for no other reason than that selection of too rank-growing budwood was practiced. I could name a dozen kinds that one now finds only by accident.

An amateur, or better still a rose grower who cultivates hundreds of specimens of each variety, could certainly find either branches or whole plants presenting characters worthy of being fixed: more abundant flowers, lighter or darker shades of color, better foliage, fewer thorns, etc. How many sports are lost because not noticed?

However, they are not all lost: as witnesses, La France, which is grown in four or five different tints and one panachée or striped rose (Angelique Veyssey); Malmaison, which exists in two colors; Baronne de Rothschild has three albinos; Reine Marie-Henriette was the origin of Madame Driout. And there are many more of the same kind, without counting a number of varieties sold as seedling variations, which are really nothing but sports.

It is especially roses of hybrid origin which present these dissociations. But there are others more ancient on which an intelligent selection would give good results, and among these are the moss roses, of which the first one known is still the best.

ROSES FROM SEED.

Rose Seedlings—Behold the infancy of the art! It is within reach of the first planter who appears. Our fathers, our uncles, have worked for us. They were expert hybridizers and cross-breeders, and when they did not hybridize, the bees hybridized for them.

Although the method is slightly played out, it still gives good results here and there. It is a lottery. Since the creation of fertile Tea hybrids, many beautiful varieties have been obtained simply by planting seeds of them. When the Hybrids Remontants flourished, it was their seeds that produced the remarkable varieties still cultivated on such a large scale in gardens and especially by commerical growers. In those days, we had to sow seeds by the thousand to produce four or five noteworthy varieties. This is the way many growers used to proceed. At the end of the season—the last of October, in the climate of Lyon—they gathered indiscriminately in collections and nurseries all the fruits that the bushes produced, without paying the slightest attention to the varieties which produced them. At least, that is the way it was done in the establishment of the late Jean Liabaud, with whom I served my apprenticeship. And that clever horticulturist had obtained in that manner beautiful varieties which are always in demand even at the present day. The rose fruits thus gathered were opened during the long winter evenings, the seeds were taken out and stratified in sand, and sowed in February in a bed not too hot, some-

times in small pots or flats, but more frequently directly in the hot-bed itself. Sometimes they were sown under a temperate glass house.

Not all the seeds which were planted germinated. Many, although perfect in appearance, contained no embryos; but enough grew each year to plant a good sized piece of ground.

If in a thousand seedlings grown in this manner, the grower found half a dozen noteworthy new varieties, he was well satisfied. It is worth noticing that the roses thus obtained from seeds did not flower at the same time. I have seen some bloom the same year they were planted, while others would only produce their first flowers after five or six years. Many had simple flowers, others half-double, some double. Some flowered scantily, others abundantly. The ones selected were grafted on eglantine (Sweet-briar), then studied, and finally put in the trade if they were worth it.

This was not the only method of procedure followed by the rose growers of Lyon. Some added seeds produced from artificial pollination between particular varieties, such as I shall discuss a little later.

WHY THEY VARY

To understand how ordinary seedlings of roses cultivated in gardens could produce anything profitable, you must remember that most of them are descendants of hybridization or cross-breeding. Now it is well known that plants descended immediately or distantly from hybrids or crosses do not come true from seed. They are endowed with innate variability. Their characters separate, combine to produce others, and run through a whole circle of variations which manifest themselves in diverse ways.

Simple propagation by seed of the best varieties of roses can be recommended, on one condition, which is to go at it with separate varieties and to follow the results by pedigree culture to the third generation. Some of the varieties have been so much sowed and resowed that in the last half century they have produced just about everything good there is in them.

Pedigree culture offers two advantages. First, the planter is not required to waste time sowing a second generation of seeds from plants which produced nothing good in the first generation. If he does not want to carry his experiments any farther, he will at least know that he has missed nothing good as far as he has gone. But if he has the intinct for plant breeding he may find in succeeding generations, if not remarkable novelties, at least good seed bearers or pollenizers—that is good mothers and good fathers, often simply semi-double, with which he can make productive crosses.

Good pollenizers or producers are rarely put in the trade by their originators, who keep the monopoly for themselves. Their influence is seen as a sort of trade mark in the varieties which are subsequently put into the trade.

Before taking up hybridizing and cross breeding, it is worth while noting that Nature has set a limit to the enlargement of flowers, to their duplication, florabundance, etc.

One more often attains large size in flowers by working through those of medium size, than by using large flowers to start with, unless the latter are semi-double. As for duplication, if it is exaggerated, the flowers do not open well, and therefore it is to be avoided. But very double roses, when they possess good pollen, can be utilized with a chance of success to fecundate—after castration—semi-double mothers. The same is followed with other genera such as carnations, petunias, Pelargonium zonale, and begonias.

By cross pollination between hybrid remontants and the yellow rose (*Rosa lutea*) M. Pernet-Ducher obtained Soleil d'Or, and following it that series of varieties which approached vermilion in color.

STERILE ROSES.

There are plenty of cases where beautiful roses are absolutely sterile, generally because their pistils are hypertrophied or atrophied. Don't waste time in pollinating them; but if they themselves possesss good pollen, it may be used on other females.

There are few genera where artificial pollination is easier to perform than with the rose. Its flowers are large, its stamens numerous, and its pistils easily seen. Furthermore, natural fecundation rarely takes place before the flowers are open.

Even if one does not know the floral organs of the rose, he can quickly learn to distinguish them. In an opened rose you see first what is called the calyx, formed of five leafy green pieces named sepals, which crown the fruit. Then the petals come, more or less numerous, and colored in different ways. In the middle of the flower are the organs of generation: stamens formed of threads carrying anthers, small yellow points containing the pollen—a sort of fecundating dust. Finally, there are the styles in the center of the flower, sometimes united, often merely crowded together. These styles are terminated by a stigma, at the top and run down to an ovule or a single seed below.

It is on this stigma that the pollen falls and fecundates the ovules. I mention these details merely for the benefit of people who have never studied the parts of plants.

To make a cross pollination, one must get a small pair of forceps, a number of small camel's-hair brushes such as are used for water colors, and as many small tin boxes as one wishes to make crosses. The reason for this is that each rose which is to be artificially pollinated may receive pollen only from the variety by which it is desired to pollinate it. If you used the same brush for a number of pollinations, you would not be sure that grains of pollen did not remain on it from one application to the next. The whole equipment costs very little.

COLLECTING THE POLLEN.

When the roses begin to open, you must begin to collect the pollen which is to be used for fecundation. The pollen of each variety is put in a separate box, on which its name is written. The anthers (stamens) should be removed with the forceps, or if necessary with the fingers. The little box is placed indoors in a dry, shaded place, and not closed tightly, in order to prevent spoiling.

The roses to be fecundated with foreign pollen should, as soon as they have opened, be deprived of:—first all their stamens, without exception; second the petals of the center of the flower, in order that these may not interfere with your own operation. When the stigmas begin to lubricate themselves, or become sticky, you bring in contact with their surfaces, by means of the camel's-hair brush, the stamens which you have previously gathered, letting them shed their pollen. After that you should cover the fecundated flower with a little bonnet of paper, in order to keep off rain. After the fruits have set, you must irrigate the plants in case of dry weather. Do not be afraid of using liquid fertilizer: one gram of phosphate of ammonia to a quart of water, and an equal quantity of saltpetre in the same amount of water.

All the fruits which were not artificially pollinated should be removed, and those which were pollinated should be allowed to ripen thoroughly before they are picked. Before the first frost in November is soon enough.

Each variety which was fecundated should be planted separately, in pots, and pedigree culture carried through two or three generations.

To find out more rapidly the probable value of certain roses as producers of novelties, it is worth while fecundating the same mother with a number of varieties of good repute as pollenizers.

It is very important to perform the operation on the first flowers which open, particularly in a cold climate where spring is late, for it is absolutely necessary that the seeds have time to ripen before the frosts of fall. Amateurs living in such climates will do well to plant the roses which they wish to hybridize in the warmest spots of the garden. In England, amateurs and nurserymen do not hesitate to cultivate their breeding stock in pots, in a well-ventilated, temperate greenhouse, in order to hasten the period of flowering, which is always late in that country. During the summer, the roses are planted in the

open ground and, if necessary, taken back under glass in October, to finish ripening their fruits.

It seems probable that a certain number of types of roses which have given good products in the past have not yet said their last word, in view of the fact that general conditions have been modified since they were first used. If the seed-producers are still the same, yet it can be said that many of the pollen carriers have been singularly modified. Since one of the parents has changed in nature, there is reason to suppose that if the old crosses were made over again, they would give different results from those originally obtained.

TO GET JULY ROSES.

I am referring particularly in this passage to a well-known type of rose of the group of bracted roses (*Rosa bracteata*), also called Macartney roses, which produced by hybridization a rose known to the trade as Rosa alba odorata, and another known as Maria Leonida. This type has remained quite constant. But the Rose of India, one of the parents, has undergone great modification since 1850. Who can say that another hybridization would not produce a different rose alba odorata, which would open easily and yet retain that precious habit of flowering in July when most roses have finished their first flowering season! I am not overlooking the fact that we have July roses on young plants grafted that same year, but on old plants they are rare.

There are other curious wild types introduced in botanical collections which seem to have been overlooked by bold and persevering hybridizers. Let me note, in passing, *Rosa xanthina*, which does not seemed to have been "worked."

And there are still others. I will limit myself to those two. Another thing. It seems that some of the paternal and perhaps maternal ancestors of some of the finest hybrid climbing or remontants have perhaps been modified, if they have not been altogether lost. While General Jacqueminot gave rise to a numerous progeny, how many replicas of different colors—aside from sports—has Baronne Rothschild produced? And Paul Neyron? And others?

It is very desirable to know how to fight in retreating, when the offensive is no longer practicable. Generals have become distinguished by such tactics—witness Xenophon and Moreau.

What precedes is merely a morsel offered to amateurs who want to try new problems and leave the beaten paths. If they attempt crosses between the old types, long crossed and recrossed, and new, untried species, they will perhaps get more failures than successes, the results of hybridization being uncertain and sometimes disconcerting. Here, however, are a few hints that may be useful:

In crossing a new type with simple flowers, which is to be used as a pollenizer, it is desirable to choose a fertile mother with double flowers, whose ancestors are also double or semi-double flowering. Duplication being highly esteemed in garden roses, the reciprocal cross may also be tried hopefully.

PRACTICAL HINTS.

In making crosses with old roses of large flowers, like Paul Neyron, it seems that success might be gained by working again the variety Anna Diesbach, with hybrid remontants, or hybrid Teas, of recent Pernetiana. That is a proposition to be verified.

With Baron de Rothschild, the ancestors might be found through atavism, after two or three generations of experiment. If so, these ancestors ought to be worked in their turn.

When one hybridizes two remontant roses, one of which although perfectly remontant has in its maternal line non-remontant roses, the products may be either single or double flowered. I had occasion to cross the Polyantha Perle d'Or (Dubreuil) by the ordinary Bengal and obtained two huge Multifloras. The characters of the Bengal and of the half-blood tea, of the Perle d'Or, had disappeared from the product. Nevertheless, every one knows that the little dwarf Polyanthas, so prolific in blooms, are the products of a cross between multifloras and tea roses, in all probability.

The Bengal type, which reproduces itself by seed, unless it has been hybridized, and which is very remontant, seems rarely to communicate its remontant character to the roses which result from its crossing. If they show, it is only after repeated crosses.

As has been said, the seeds of hybrid roses are not always fertile even though perfect in appearance, their fecundation having apparently, but not actually, succeeded. For this reason one must try various pollens, when one is certain that the mother is fecund with her own pollen, for she does not always accept the first pollen offered.

Material for Plant Breeders.

Plant breeders actually engaged in experimental work in the United States, and desirous of obtaining material for use in their breeding experiments, are reminded that the Office of Foreign Seed and Plant Introduction of the Bureau of Plant Industry, Washington, D. C., makes it part of its business to secure such material from any part of the world. Many thousands of species are brought in each year, and inventoried, and the most important are described in monthly mimeographed leaflets issued by that office. Bona-fide breeders who are not now in receipt of these, but desire to receive them, with a view to securing material for work in their experiments, may secure the leaflets regularly by writing to the Agricultural Explorer in Charge, at the address above.

Dysgenic Philanthropy.

It is a fact, disguise it as we will, that we have taxed ourselves to support institutions which have resulted in increasing, not decreasing, the number of the unfit. We have before us an immediate duty, of tremendous importance, in caring for our unfit; in seeing to it, by adequate legislation, that the insane, the habitual criminal, the feeble-minded and similar classes are *permanently* segregated, so that they cannot reproduce their kind to be a further burden upon the nation, and that the marriage of those whose offspring will be unfit shall be prevented.—Robert DeC. Ward: The Crisis in our Immigration Policy (Inst. Quar., IV, 2, 1913).

Eugenics and Immigration.

A democracy can not endure unless it be composed of able citizens; therefore it must in self-defence withstand the free introduction of degenerate stock.—Francis Galton.

The Problem of the Feebleminded.

In these simple and practical ways—by specially training the feeble minded, by confining them in suitable institutions and colonies, and by voluntary sacrifice of procreative power by those who are able to work in the world—we shall be able, even in a single generation, largely to remove one of the most serious and burdensome taints in our civilization, and so mightily work for the regeneration of the race.—Havelock Ellis: The Problem of Race Regeneration (1911).

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CONTENTS

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ANCESTORS OF THE KARAKUL BREEDS

At the left is a black Danadar ewe, which as is easily seen is a *longtail*. Anatomically it greatly resembles the Small Arabi Karakul, which has been produced from it by the admixture of fatrump and other blood. This ewe shows a considerable admixture of fine wool. At the right is a gray Danadar, also a longtail. The gray Danadar breed has been produced by crossing white, fine-wool Afghan sheep on the black Danadar, and consequently represents one step in the creation of the Karakul (small Arabi) breed which is so highly valued today. (Frontispiece.)

NATURE OF MENDELIAN UNITS

All Extensive Researches Indicate that so-called Units are Groups of Very Small sub-characters, and not Indivisible Units—Alternative Inheritance no Evidence of Discontinuous Evolution—Importance to Eugenics of Understanding True Nature of Characters.

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THE discontinuous nature of Mendelian inheritance is often taken as evidence that evolutionary progress is also discontinuous. When two varieties appear to differ in a single conspicuous character and this character is found to behave as a unit in the progeny of crosses between the two forms, it seems reasonable to infer that the character sprang into existence abruptly. The failure to secure intermediates among the hybrids certainly suggests that there was a corresponding absence of intermediates when the character arose.

This line of reasoning has not gone unchallenged, but most Mendelians continue to look upon characters as units and many are so unbending as to continue in the belief that the units are unchangeable. It is the purpose of the present paper to discuss the bearing of Mendelian inheritance on the origin of characters and to suggest an extension of the theory of factored characters. Reasons are advanced for believing that all visible characters are complexes of minute sub-characters which have become coherent through long association.

During the years immediately following the revival of Mendel's discovery, many alternative characters were investigated and the crosses were regularly reported as showing no intermediates and as giving in the second generation the 3 to 1 ratio of the simple Mendelian hybrid. Results of this kind are most easily explained by assigning to the germ plasm a single representative for each character. As the study of these hybrids was continued with more minuteness, and crosses were made with types possessing characters different from either of the original alternative pair, dihybrid ratios were reported with increasing frequency. A dihybrid ratio is interpreted as indicating that the character, instead of being simple, is in reality a combination of two sub-characters or factors. These factors when considered singly still behave as simple Mendelian units, but the combination necessary to produce the original character will occur in other than the 3 to 1 ratio. The instances where the slightly more complicated dihybrid ratios were followed with approximate exactness were sufficiently numerous to warrant continuance in the belief that the law of complete and equal segregation was of very general application. But there were also many alternative characters which showed by the still more complicated hybrid ratios that the original characters must be represented by three, four or even more factors. With more than three factors, it has seldom been possible to conduct experiments on a sufficiently large scale to determine whether the ratios are followed with exactness or not. The fact that individuals occur in the later generations of the cross which reproduce the character in its original form, and that some of these breed true, at least for several generations, affords evidence that we are still dealing with a complicated form of the originally simple law.

THE LIMIT OF ANALYSIS.

From characters composed of only three or four sub-characters, there is now perfect gradation to characters, such as height and weight, where the different stages, if they exist, are com-

pletely masked by fluctuations. In crosses involving such characters as height, even the reappearance of the characters in their original form can not be verified, and the only evidence that we are still dealing with Mendelian phenomena lies in the fact that the blend of the first cross does not persist and the extremes represented by the original parents of the cross are attained or even exceeded in the subsequent progeny of the cross. It seems not illogical, however, to assume that the differences, though very minute, are still inherited in the same discontinuous manner. That we have passed the limit of analysis is certainly no reason to assume that we have passed outside the realm of law.

It has been shown, however, that the Mendelian behavior of minute differences would produce results in accord with continuous evolution and Galton's law of inheritance. The possibility of reconciling Mendelian inheritance with Galton's laws was early recognized by Yule.[1]

While the inheritance of blended characters, such as height, may be brought into accord with Mendelian inheritance by the assumption of a sufficiently large number of factors, such inheritance can be held to be discontinuous only in the sense that curves are held to consist of a series of straight lines. An array of variations may fit the normal curve of continuous variation and at the same time comply with the Mendelian laws of discontinuous inheritance, provided only that the differences between the units are sufficiently minute.

To return now to characters which are inherited in a conspicuously discontinuous manner, is it not possible that here the individual stages in the development of the character are also numerous and extremely small? There are still many gross characters that stand as simple Mendelian units, but few, if any, of these occur in plants or animals that have been subjected to extensive investigation. There is now such a large number of characters which at first behaved as units, but which have since been broken up by crossing with suitably selected material, that it seems not unreasonable to believe that the remaining cases await only the discovery of the right strains with which to hybridize them to bring about corresponding results. Even if the strains necessary to subdivide the characters no longer exist, we may still look upon the residue of "unit characters" as composed of an indefinite number of "factors," which arose independently but are now inseparably associated.

One of the best examples of a single Mendelian character is the horny endosperm of the seeds of certain types of maize, as contrasted with the wrinkled endosperm of the sweet varieties. The simple Mendelian ratio that follows the crossing of the sweet x horny varieties has been demonstrated with greater exactness than for any other character pair. Taking only the results of Lock, East and Hayes, and Halsted, the number of individuals classified reaches nearly 100,000. With numbers of this magnitude, deviations from the expected 3 to 1 ratio as small as one-half of one percent. could be detected with assurance. Many different varieties have been crossed and always with the same result: the difference between wrinkled and horny endosperm behaved as a simple Mendelian unit. When, however, a variety of maize with an endosperm that was neither horny nor wrinkled came to be crossed with sweet varieties, a horny endosperm was formed which segregated in accordance with a dihybrid ratio, showing that this character, which had behaved with such wonderful regularity, appeared as a unit simply because it had not been resolved into the elements or factors of which it was really composed.

That we have not yet found a variety of maize that will still further subdivide these endosperm characters is slight reason for assuming that the

[1] New Phytologist, Vol. 1, Nos. 9 and 10, 1902.

A mathematical demonstration of the close agreement between the Mendelian behavior of minute factors and Galton's law has been given by Brownlee, 1910: Proc. Roy. Soc., Edinburgh 30, P. 473, and 1911, 31, P. 251.

factors, as we now understand them, are ultimate and indivisible or that they originated by single steps.

COMPLEXITY OF CHARACTERS.

Even the simplest visible character is of such a complex nature and requires the interaction of so many elements that the simultaneous origin of the individual elements, all properly correlated, is difficult of conception. The possibilities of subdivision are not limited, even to visible factors. Analytical breeding has shown that many of the elements of a visible character, if they exist alone, are entirely invisible. Factors for pattern and intensifying factors may be combined, segregated, and recombined, and yet give no visible evidence of their existence until united with the necessary factor for pigment. In many instances this subdivision into factors continues to the limit of our ability to analyze, and beyond this point we have no way of knowing to what degree of minuteness subdivision may extend. One result of this class of investigations is to bring to our minds a realization of the multitude of diversities that actually exist, but concerning which our senses give us no direct intimation.

The problem of evolution has been attacked from one side by biometricians and others adhering to the idea of gradual change, and from the opposite side by the followers of De Vries and Mendel. The field between them has been narrowed until the two forces are now within sight of each other. There are still many points of divergence, but all that remains of the question as to whether or not evolution proceeds by abrupt steps is a different terminology and a different point of view. If the individual steps by which evolution proceeds are too small to be distinguished, the question whether evolution should properly be termed continuous or discontinuous is chiefly of academic interest.

The futility of the distinction between blended and discontinuous inheritance has been appreciated by Reid:[2] "Adherents of the Mendelian doctrine sometimes maintain that blended inheritance is nothing other than a fine mosaic. Doubtless they are right; but I imagine their opponents mean nothing more by blended inheritance than that it is a very fine mosaic—a mosaic as fine, perhaps, as the mixture of colours in a painter's brush. All blending, for example a mixture of alcohol and water, is a mosaic, even if one of chemical molecules."

With the idea of illustrating how this common viewpoint may be applied to characters that behave as simple Mendelian units, the evolution of a hypothetical character may be traced.

In the palms, the pinnate type of leaf is held to have developed from forms with palmately divided leaves. In the typical palmate leaf, such as Chamaerops, the veins all arise from the tip of the petiole. Let us assume that in a geographically segregated group, the tip of the petiole or point of origin of the veins becomes gradually elongated. This elongation continues until the pinnae are finally separated and the pinnate type of leaf is attained. The magnitude of the individual steps by which this development procedeed, we assume to have been as small as the differences now observed between individuals of existing species. If now a palm of the pronounced pinnate type, such as Cocos or Phoenix, could be crossed with a Chamaerops, the type of leaf would doubtless Mendelize, perhaps without intermediates. It would then be assumed that the difference in leaf form was represented by a unit character and that this difference represented a single step in evolutionary progress. If, however, some species with a third type of leaf should come to light, say such a plant as Sabal, that has a leaf intermediate between the palmate and pinnate types, and this new form could be crossed with the Chamaerops or Phoenix, it would then be found that the leaf character separating Chamaerops from Phoenix consisted of two factors, each of which might still be found to Mendelize, thus halving the apparent evolutionary step. Further subdivision of the character would depend on whether

[2] Reid, G. A., "The Laws of Heredity," P. 155, footnote.

other types could be found representing still other stages in the evolutionary development or possessing a different assortment of factors. If a sufficient number of these intermediate types were available, the forms would increase until the differences became so small that, although the different stages might still behave as Mendelian units, the fact could not be definitely demonstrated.

THE LAW OF SEGREGATION.

Looked at from this standpoint, the law of segregation may be said to hold good. The difficulties and inconsistencies in its application have resulted from the assumption that visible differences are "unit characters" represented by single determiners. According to the interpretation here advanced, visible characters are to be looked upon as complexes of an indefinite number of heritable elements which are so small as to be immeasurable and which are more or less tenaciously united. On the degree of coherence, or tenacity with which the elements are bound together, depends the apparent regularity of the Mendelian behavior. If the elements remain inseparably associated, the inheritance follows the simple monohybrid ratio. If the elements separate into two or three groups, di- or trihybrid ratios result. If the association of elements is still more completely dissolved, the inheritance is blended and apparently non-Mendelian. On breaking up the characters, smaller groups of slightly coherent elements may form, and these groups themselves may not be entirely independent. It is thus possible to account for cases in which indications of both mono- and dihybrid ratios occur with respect to the same visible character. With characters that are strictly alternative in their nature, dissolution results in aberrant or complicated ratios. Where intermediate stages of the characters can come into expression, dissolution results in indistinct classes and apparently imperfect segregation.

The difference between the waxy and horny endosperm of maize affords a good example of a character whose expression is definitely alternative. Intermediate forms are completely absent, the nearest approach to an intermediate being the extremely rare occurrence of seeds in which both horny and waxy endosperm are present as a mosaic. The inheritance of endosperm texture in horny x waxy hybrids behaves as a simple Mendelian character, and this behavior was thought to be perfectly regular until the use of larger numbers of individuals made it possible to determine the ratio with greater accuracy. It was then found that instead of the mean percentage of waxy seeds being the expected 25, it was in reality only about 23.

If the coherence between the various genetic variations that result in changing waxy to horny endosperm was absolute the Mendelian behavior of the characters would be regular, but if one or more of the elements was occasionally disassociated from its fellows there would result a variation from the expected 25% of recessives.

The change from waxy to horny may be likened to a chemical change that accompanies the transition from an acid to an alkaline reaction, or the change from a solid to a liquid state that follows a rise in temperature. The increase in alkalinity or the rise in temperature may be slow and continuous, but the resulting change in appearance is abrupt.

MANY CASES REPORTED.

Examples of coherence and the factoring or subdivision of characters are constantly being reported. Castle has shown that some Mendelian characters are amenable to change by selection. The latest results in this line are those of Castle and Phillips. In a series of carefully planned experiments, it is shown that the hooded character in rats, which exhibits perfectly blended inheritance between different stages or degrees of the character, may still behave as a unit, giving monohybrid ratios when crossed with forms not showing the character.

After changing the mean of the hooded character in both directions by selection, individuals were crossed with the wild stock which is not hooded. The wild form is dominant and the

hooded character reappears in one-fourth of the progeny in the second generation. The result of the crossing, however, appeared to undo the work of selection. Thus, when a member of the strain in which the amount of white had been increased by selection was crossed with the wild type, the extracted hooded individuals showed less white than the hooded parent; and when a member of the strain in which the white had been reduced was used, the extracted hooded individuals showed more white than the hooded parent.

That typical Mendelian characters are amenable to change through selection is held to prove that unit characters are variable. The apparent undoing of the work of selection by crossing with the wild type has induced the authors to grant the probable existence of "modifiers," but the "main factor" is still considered as a unit. May not the results of these experiments be brought into closer harmony with those of other investigators if this "main factor" is looked upon as a rather tenacious group of minute factors similar in nature to the detached "modifiers"?

Paleontological records afford further evidence of the gradual evolution of characters that are discontinuous in inheritance. While the evidence from this source is direct, geological records are seldom sufficiently complete to observe differences as minute as those brought to light by analytical breeding. Professor H. F. Osborn has carefully traced the development of cranial and dental forms in some of the mammals. He shows that a number of the characters that distinguish the horse from the ass afford no evidence of discontinuous origin, but appear to have developed gradually from very small beginnings. Yet there is evidence that the resulting differences, as they now exist, behave as units. The sterility of the hybrid has made it impossible adequately to test the Mendelian behavior, but Professor Osborn shows that these characters exhibit the phenomenon of dominance in the first generation. The behavior is thus shown to be Mendelian as far as it goes. Professor Osborn says:

"It is true that the evidence for discontinuity in the *heredity* of characters is as convincing as that for discontinuity in the *genesis* of character is debatable," and some characters "while apparently continuous in origin certainly become discontinuous in heredity; from which it follows that discontinuity in heredity constitutes no proof of discontinuity in origin."[3]

A WARNING TO EUGENISTS.

Once the complex nature of visible characters is fully appreciated, less confidence will be placed in the purity of the germ cells. Is it safe to assume that an undesirable character introduced into a hybrid with one of the parents has left no trace or tendency in those members of the progeny which on Mendelian analysis show the alternative character? Since the rediscovery of Mendel's laws, this question has been acute, but most practical breeders still remain skeptical. With the greatly increased interest in eugenics, the importance of deciding this question is brought home to a large part of the thinking public. In the light of recent research, for one to assert with confidence that a heritable human defect, which investigations have shown to be a dominant character, is completely absent from offspring that fail to show the defect, regardless of its prevalence among their ancestors, indicates a complete failure to appreciate a grave responsibility. Mendel's laws may be inexorable, and yet all the elements which go to make up a physiological or mental defect may not always remain associated.

Complete analysis of characters in man is impossible at present, and expectation regarding the behavior of undesirable characters must be largely inferred from analogy. So many of the characters which in other species have been exhaustively studied have been found resolvable that it appears unscientific as well as dangerous to assume that the segregation of gross pathological characters is complete in the human species. Individuals that are pure recessive with respect to what appears as a simple

[3] Osborn, H. F., The Continuous Origin of Certain Unit Characters as observed by a Paleontologist. American Naturalist, 44, 186-7.

Mendelian character may still carry some of the elements of the character. There are no pure strains in the human species, and any union may bring together the complementary elements that will cause an undesirable character to come into expression.

A Warning to Eugenists

Condemnation of haste in "eugenic" legislation is voiced by the State Charities Commission of Illinois in its fourth annual report. The commission says:

"We do not favor the enactment into laws of the principles which the eugenist has promulgated. They are worthy of public thought and consideration. But whatever of merit they contain, to be effective, must be accepted voluntarily by an enlightened and quickened public conscience, and not forced upon it by statutory enactment. Much more can be accomplished in this field by the dissemination of clearly demonstrated facts than by attempt to impose by law upon the public poorly understood or wholly misunderstood principles of human conduct and life.

"Many eugenists are going to extremes. They are responsible for the ridicule into which a serious subject has been plunged. The science of eugenics is a dignified, deep and serious study of the tremendous problems of human life. It is entitled to respect and to respectful consideration. The popular conception, formed through flippant reference to eugenic marriages, eugenic babes, eugenic dramatic productions and eugenic novels, has resulted in its falling into more or less disrepute.

"The pioneers in the science have advanced ideas which are worthy of the most careful thought, whether we believe in them or not. Any movement whose object is to improve the race, elevate the standard of mentality and make life better and nobler, should not be prostituted as this science has been."

The Wisconsin Marriage Law

The weekly Report of the United States Public Health Service (Vol. 29, No. 37, Washington, D. C., Sept. 11, 1914) publishes the opinion of the chief justice of the Wisconsin supreme court, upholding the so-called "eugenic marriage law" and also the dissenting opinion rendered by two of the members of the court. The law, which has been in force since the beginning of this year, and provides for a medical examination of "all male persons making application for license to marry," was attacked as unconstitutional, and the court of first trial upheld the attack. In the supreme court "the case really turned on the question whether or not the language of the law required the application of the Wassermann test. . . . The majority of the court held that the legislature did not intend to require the Wassermann test." The statute as thus interpreted would appear to be even more useless than its opponents have from the start declared it to be.

TREE GROWTH AND SEED

Swiss Experiments Show How Main Characteristics of Parent's Growth are Inherited by Seedlings—Seed Must be Selected with as Much Care in Forestry as in Horticulture—Limited Effects of Environment in Overcoming Bad Heredity.

James B. Berry

Department of Forestry, Pennsylvania School of Agriculture, State College, Pa.

AT THE Forest Experiment Station near Zürich, of which Dr. Arnold Engler is Director, are a number of interesting investigations under way[1] which illustrate the inheritance by seedlings of the main characteristics of the parent tree. No plant breeder doubts this in the least, yet the fact remains that the purchaser of tree seed seldom questions its source, and then as to region only. For instance, two plots are covered with a good growth of spruce seedlings varying in height from three to 10 feet. The seedlings on Plot I show more than 50% crooked and twisted, unfit for the production of high class material, while Plot II contains less than 5% of material of this character—a variance at once noticeable. Inquiry as to the history of the two plots brings out these facts:

1—that the seedlings on Plot I originated from seed collected from a mother tree of gnarled and twisted form—yet not an extreme form.

2—that the seedlings on Plot II originated from seed collected from a mother tree of normal form.

3—that the two mother trees—the deformed and the normal—occur in the same quality site under similar conditions of light, heat and moisture.

A second experiment occupies two adjacent plots, both supporting a growth of spruce seedlings about fifteen years of age, the planting distance being the same in the two cases. The seedlings on Plot I, while entirely healthy and vigorous, are rounding in form, very dense in character and the branches are uniformly small. Plot II supports a growth of seedlings entirely normal in form and rate of growth. The seedlings on Plot I ranged between 12 inches and 30 inches in height, and were as broad as high; the seedlings on Plot II ranged between three and six feet in height. The history of the plots brings out these facts:

1—that the seedlings on Plot I originated from seed from a mother tree which was characterized by density of branching and slow growth, but of normal form.

2—that the seedlings on Plot II are the product of seed collected from a mother tree of normal form and growth.

3—that the two mother trees—the dense and the open, the slow growth and the normal—occur on the same quality site under similar conditions.

Spruce forms the basis, also, for a third investigation; namely, the effect of temperature in its relation to transmitted characteristics. Seed was collected from regions of mean temperature varying by 10° F, from that of Zürich to northern Sweden, altitude and latitude both forming a basis for computation. Two or three rows were planted from each lot of seed, the arrangement being in regular order from the lowest to the highest mean temperature. Today, eight years after the inauguration of the experiment, there results a "terrace"-like formation, the relative height growth varying directly with the mean temperature. Another interesting feature of the same experiment is that it brings out the fact that the length of

[1] See also Engler, Arnold. Influence of Source of Seed. Journal of Heredity, V, 4, 185, April, 1914.

SCOTCH PINES AT THE ZÜRICH STATION

In the United States the Scotch pine (*Pinus sylvestris*) is frequently said to give very poor results. Seedlings grown at the Zürich experiment station, however, from very diverse sources, indicate that with proper seed selection, good stands can nearly always be obtained; and observation in many other localities on the continent, under all sorts of conditions, confirms the belief that if seed from good trees and suitable regions were selected for planting in the United States, the Scotch pine might be considered very successful. The influence of the source of seed on the character of tree growth has long been neglected, but is now beginning to receive the attention it deserves. (Fig. 1.)

GROWTH HABIT OF THE NORWAY SPRUCE

Important conclusions as to the effect of environment on seed are being drawn from a study of the Norway spruce at Zürich, Switzerland, by Arnold Engler. It is found that seeds collected from trees of normal, open growth reproduce this habit, while seed collected from trees of stunted, twisted, or gnarled form tend to produce trees almost worthless for lumbering purposes. It is also found that seed from high altitudes produces trees that have a short growing season, even when planted in much lower altitudes. The importance of seed selection thus becomes as great to the forester as it long has been to the gardener. (Fig. 2.)

growing season becomes a fixed character of tree growth; that is, that the length of the period of active growth varies directly with the mean temperature of the plant's habitat. Thus, the plants, resulting from seed from a locality of high mean temperature, are the first to show active growth in the spring; while those resulting from seed from a region of low mean temperature will be last. A shorter growing season is also characterized by a lower annual increment as well as by density of form.

APPLYING THE CONCLUSIONS.

The practical application of these facts is easy, and here is also found an explanation for some of the poor results in forestry. For instance, it is said that Scotch Pine (*P. sylvestris*) gives very poor results in the United States and that, therefore, it is not adapted to this country. It is true that in Europe one does find poor stands of this species, yet, on the other hand, there also occur very fine stands. Other conditions being the same, does it not seem reasonable to place the blame upon the source of seed?

In a region where the snow-fall is heavy and the snow is of such a character that it c ings to the branches and leaves, producing heavy damage through snow-break, the seedling resulting from

seed from a region of higher mean temperature is most affected, since the long, willowy, previous year's growth is easily forced out of shape, becoming a cripple if not actually broken. Because of the longer period of growth these seedlings are also more liable to damage through early and late frosts. These facts are now generally accepted by German foresters and, in mountainous regions, it is common to find a forest nursery for each 500 feet of elevation, the object being to collect the seed and grow the seedlings under conditions common to that general elevation. The suggestion has been made that the nursery should be at a high elevation, yet this is considered as impracticable as having it at a low elevation. In one case the rate of growth is too slow; in the other, the susceptibility of damage and destruction is too great.

Certainly these facts should have a very great influence in the selection of seed, yet the contrary seems the rule. Commercial seed is collected, not always from the best formed and most vigorous, but often from the deformed and dwarfed; simply because the inferior specimens often produce the heaviest crops of seed and this seed is more accessible to the collector. With the same faulty method of reasoning the lumbermen, and often the Forest Service, leave the deformed, the cripples and the weeds to provide for the new forest. Garden and field seeds are being constantly improved through selection and the various State Experiment Stations have undertaken an inspection of seed handled by the large dealers, so that the purchaser may have some guarantee of cleanliness and purity. With tree seed, however, nothing but cleanliness is considered, the character of the parent trees being entirely ignored. Even in work performed by the Forest Service the object has been, too often, "cheap" seed, rather than from the "best" trees. Collecting seed of the trees of a forest indiscriminately is on a par with selecting seed corn as it comes from the sheller. As a matter of fact the selection of tree seed to reproduce a forest is perhaps more important than the selection of seed grain to produce a field of grain, since the profitability of forestry is dependant to so great an extent upon rate of growth and length of rotation. While it may not be possible to have a "seed plot" as in corn growing, it is certainly possible and practicable to gather seed from well-formed, vigorous. rapid-growing individuals only—always bearing in mind that the characteristics desired in the new forest must be present, to a large extent, in the individual parent trees from which the seed is selected. Only to a comparatively small extent can the defects of poor seed be overcome through cultivation.

EUGENICS IN GERMANY

Society For Race-Hygiene Adopts Resolutions Calling For Extensive Program of Positive Measures to Check Decline in Birth-Rate.

G. Von Hoffmann,
Austro-Hungarian Consul General at Berlin, Germany.

THE GERMAN Society for Race-Hygiene, Munich, founded in 1905, at its last annual meeting in Jena discussed the declining birth-rate and published a series of resolutions on the subject. The topic was chosen in view of the fact that restrictive eugenics ordinarily dominate similar assemblies and the literature, thereby causing in the public the wrong impression that positive eugenics are of a subordinate importance. The chief difference between the resolutions of the Society and utterances on the same subject coming from other sources is found in laying more stress upon the inner moral forces of men. It is not necessary to emphasize that although the danger of the declining birth-rate is great in Germany, the decline is even worse in many other countries.

The resolutions are the following:

A. The Situation.

1. The future of the German people is at stake. The German Empire can not in the long run maintain its true nationality and the independence of its development, if it does not begin without delay and with the greatest energy to mould its internal and external politics as well as the whole life of the people in accordance with eugenic principles. Most important of all are measures for a higher reproduction of healthy and able families.

2. The rapidly declining birth-rate of the healthy and able families necessarily leads to the social, economical and political retrogression of the German people.

3. The insufficient reproduction is partly caused by the encroachment on the reproductive faculty of gonorrhoea, syphilis and alcohol.

4. But the main cause of the declining birth-rate is at present the *increasing wilful restriction of the number of children.*

5. The most important motives for the restriction of the number of children are:

(a) The fear of economic disadvantages and of the difficulties attending care and education of children in consequence of a large family,
(b) considerations of inheritance,
(c) the impossibility to reconcile women's out of home work with the education of a large number of children,
(d) the embarassment caused by the housing systems in large cities.

6. The decline of the birth-rate is greatly hastened by the shamelessly advertised manufacture and organized sale of means preventing conception or causing abortion and by the propaganda of Neomalthusianism.

B. Prevention.

In order to secure a posterity sufficient in number and ability, the German Society for Race-Hygiene demands:

1. Furtherance of inner colonization [back-to-the-farm movement] with privileges of succession in favor of large families.

2. Creation of family-homes for large families in cities (garden-cities, small cottages with gardens, etc.).

3. Economic assistance of large families through payment of a substantial relief to married mothers who survive their husbands, and consideration of the number of children in the payment of public and private employees.

4. Abolition as far as possible of certain impediments to marriage which

in European countries are now imposed on officers in the army and government employees (for instance, they cannot marry before the attainment of a certain grade).

5. Increase of taxes on alcohol, tobacco and luxuries for purposes enumerated in No. 3. (A tax is further asked to be imposed on all who on account of their physical inability do not serve in the army. Such a tax exists in Austria, Hungary and Switzerland.)

6. Legal regulation of procedure in all cases necessitating abortion or sterilization. (This means that the medical indication should be made more stringent, for instance by the provision that two physicians be consulted before an operation is executed. The sterilization for eugenic reasons is covered by this paragraph, but has not been specifically included, as the time has not yet come for such a measure in Germany.)

7. Fight against all evils encroaching upon the ability to reproduce, in the first place against gonorrhoea and syphilis, tuberculosis, alcoholism, industrial poisons and evils endangering the health of working women.

8. Obligatory exchange of certificates of health before marriage.

9. Setting out large prizes for excellent works of art (novels, dramas, plastic arts) which glorify the ideal of mothership, the family and simple life.

10. Awakening a national mind ready to bring sacrifices, and a sense of duty toward coming generations. Vigorous education of the youth in this sense.

The German Society for Race-Hygiene earnestly applies to all who are convinced of the correctness of these principles, for cooperation in order that the needed legal measures be enacted before it is too late.

For an Exhibit of Hybrids

In connection with the annual meeting of the American Genetic Association at San Francisco in September, 1915, it is proposed to give members an opportunity to exhibit interesting hybrids, either of plants or animals. These will probably be installed at the University of California, where an unusual series of cross-bred forms of tobaccos and walnuts will be shown. The Association will undertake to care for exhibits sent, but can not assume any expense in connection with their transportation. The secretary will be glad to hear from members who can contribute interesting productions for this display.

HOLSTEIN MILK YIELD

Examination of Records in Blue Book Furnishes no Support to Idea That Milking Capacity in Cows is Transmitted Through Males Rather Than Females.

F. R. Marshall,

Senior Animal Husbandman in Sheep and Goat Investigations, Bureau of Animal Industry, U. S. Department of Argiculture, Washington, D. C.

THERE seems to be a growing tendency to direct the study of inheritance to a greater extent along utilitarian lines. It is quite possible that some of the principles that obtain in inheritance of coat characters may also apply to capacity for certain kinds of work or production, or at least to factors that contribute to such capacity.

While actual tests and specially planned matings are altogether necessary and desirable, yet there is considerable material at hand that may profitably be studied until more desirable data is available. Such material is contained in the Year Book for the American Trotting Register, which shows the records of all horses that have trotted faster than 2:30, arranged under their sires and dams. This book does not record the non-performing offspring of any matings. In its present form the Year Book was regarded by Galton as furnishing material of value for statistical study, as evidenced by the use he made of the same.[1]

The Advanced Registers for dairy breeds of cattle also show what animals have met prescribed standards and give opportunity for tracing their ancestry and knowing the records of the ancestors. Here too we are dealing with selected material, as there is no mention of non-record-making offspring. The study reported in this article relates to inheritance through paternal and maternal lines, of factors controlling the production of butter fat.

The work was done by Perry Van Ewing, now with the Georgia Experiment Station, and was presented as the thesis requirement for a M.Sc. degree granted by the Ohio State University in 1913. It is a continuation of another study made at that institution by W. O. Reagin and reported in the American Breeders' Magazine.[2]

Ewing's results are of special interest in connection with Cole's reference[3] to the prevailing impression that, "the males of dairy breeds, generally, are prepotent in the transmission of the characteristics of the females of their race." It was the foregoing statement that first suggested an examination of records of cows as reported in the Blue Book compiled annually from the Advanced Register for the Holstein Breed. In Volume 10, there were found 1317 cases of cows having official records and whose paternal grandams also had records. In addition, there were 687 cases in which a record-making individual had a maternal grandam with a record. These were all seven-day records, made

[1] Proc. Royal Soc. London, Vol. 72, no. 384, pp. 310–315. 1898.
[2] Vol. 3, No. 2, p. 148.
[3] Vol. 4, No. 3, p. 160, American Breeders' Magazine. "Among cattle breeders we find a prevailing impression that 'the males of dairy-breeds, generally, are prepotent in the transmission of the characteristics of the females of their race' (Miles, op. cit., p. 231). Sedgwick is quoted in the same place as saying: 'It is well known, for example, that the supply of milk by cows is hereditarily influenced by the bulls rather than by the cows from which they are directly descended, and that the character of the secretion, as regards both the quantity and the quality of the milk, is chiefly derived from the paternal grandmother * * *.'
"This, if true, would fit in well with sex-limited inheritance, and such indeed it may ultimately be found to be."

at various ages and giving the pounds of milk yielded, pounds of fat and per cent. of fat.

The difficulty of variation in age was overcome by arranging the "paternal grandam" and "maternal grandam" cards in two parallel sets. Having a much larger number in the paternal set it was possible to select therefrom, for each maternal card, one in which the age of the cow and of the grandam corresponded very closely. This arrangement left 665 cards in each group.

The coefficient of correlation for each group in respect to total milk, total fat and per cent. of fat, is shown below:

SUMMARY OF RESULTS.

	M	Em	σ	Eσ	r	Er
Pounds of Milk						
Through Sires						
Granddaughters	370.6	±2.29	88.5	±1.67	–0.05	±0.025
Grandams	475.3	±2.56	98.7	±1.95	–0.05	±0.025
Through Dams						
Granddaughters	393.4	±2.63	99.5	±1.95	–0.012	±0.02
Grandams	437.4	±2.09	80.8	±1.54		
Pounds of Butter-fat						
Through Sires						
Granddaughters	12.68	±0.089	3.41	±0.062	–0.04	±0.025
Grandams	16.93	±0.108	4.14	±0.076		
Through Dams						
Granddaughters	14.00	±0.101	3.97	±0.07	0.06	±0.026
Grandams	15.83	±0.087	3.31	±0.06		
Percentage of Butter-fat						
Through Sires						
Granddaughters	3.47	±0.009	±.432	±0.008	0.107	±0.02
Grandams	3.57	±0.011	±.448	±0.008		
Through Dams						
Granddaughters	3.55	±0.011	±.445	±0.008	0.213	±0.02
Grandams	3.50	±0.013	±.488	±0.009		

Taking the opposing pairs of cards as they came to see in which there was the greatest similarity between records of granddaughter and grandam the following results were obtained:

	Number cases in which resemblance was closest on Maternal side.	Number cases in which resemblance was closest on Paternal side.
Pounds of milk	403	262
Pounds of Butter-Fat	407	258
Per cent. of Butter-Fat	345	320

In the two sets of cases already discussed there was a smaller number of paternal than of maternal grandams, due to fact that cows have many more granddaughters through their sons than through their daughters. This objec-

tion and the further objection as to environmental influence upon total production is removed in a further study relating entirely to per cent. of butter-fat.

In the second part of the study of this case there were taken 126 record cows having record granddaughters through both sons and daughters. The number of granddaughters is 340 through paternal descent and 340 through maternal descent from 126 common grandams. Each grandam was represented by not less than one nor more than six granddaughters in either line. Here also the ages of granddaughters and grandams in one line corresponded closely with those in the other line. The means, standards of deviation and coefficients of correlation in this case of common grandams were as follows:

Paternal Descent	M: % Fat	E	σ	E		
Granddaughters	3.52	±.02	.442	±.01	√	= .157
Grandams	3.51	±.02	.406	±.01	E	0.028
Maternal Descent.						
Granddaughters	3.60	±.02	.489	±.01	√	= .155
Grandams	3.51	±.02	.406	±.01	E	± .028

The difference between .155 and .157 does not indicate any difference between transmission of the character of percentage of butter-fat in the milk, through males and females. The impression to the contrary, held by some cattle breeders, is probably based upon specific instances in which the bull used was more strongly bred than were the cows with which he was mated and unusually prepotent on that account.

THE SIAMESE POMELO

Perhaps the Finest in the World—Several Types Seem to be Genuinely Seedless—Occasional Seed-production Probably Due to Cross-pollination.

H. H. Boyle

Bureau of Agriculture, Manila, P. I.

FOR many years, horticulturists throughout the world have heard stories of a wonderful seedless pomelo in Siam, which was reputed to be finer than anything else of that sort known to science, but which, for some reason, always seemed to elude the long grasp of the men who are engaged in the work of securing new plants for breeders in the various tropical and sub-tropical regions. It was 12 years from the time I first became interested in this fruit to the time when I actually saw it, but it is now established in the Philippine Islands, has been introduced to the United States and will, I believe, spread throughout the warmer portions of the world, as the finest grapefruit cultivated.

As early as 1902, when I was employed in the Office of Foreign Seed and Plant Introduction of the U. S. Department of Agriculture, we secured plants of this pomelo, as the result of a long correspondence carried on by Mr. Fairchild, in charge of the office. Prince Chow, Phya Bhas Karawongse, sent through G. B. McFarland of the Wang Lang Hospital, Bangkok, a Wardian case of six trees propagated from those in the private garden of the King of Siam at Bangkok. Due to the long journey and improper handling en route, only one plant arrived in Washington alive. After being nursed to a healthy state, it was planted in the orange house with much solicitude, for the rapidly increasing interest in the pomelo as a breakfast fruit caused every citrus grower in the United States to take an interest in the introduction.

In a few years it bore several large fruits, which were cut with much ceremony. Imagine the disappointment when it was found that these "Siamese Seedless Pomelos" contained more seeds than the ordinary seedy pomelos of the United States; that the rind, instead of being a quarter of an inch thick (the average for United States pomelos) was at least an inch thick; and that the segments were numerous and tough in texture. In short, the fruit was inferior to any of the recognized varieties grown in the United States, and the one tree was destroyed. For many years thereafter the Siamese seedless pomelo remained an enticing but baffling mystery.

In 1911 I was transferred to the Philippine Bureau of Agriculture, and shortly afterward learned from C. A. Steele, a Siamese acquaintance, that while the seedless pomelo was not common in Siam, it nevertheless did exist in certain parts of the country. A few months later he sent us a small shipment of budwood. In 1912 the Bureau received from a passing traveler a present of four fruits which, upon inspection, fully justified the almost legendary reputation of this pomelo. We had before our eyes the substantial evidence that the famous product was not a myth, as many had claimed, but that it was one of the finest citrus fruits ever propagated.

TRIP TO SIAM UNDERTAKEN.

As a result of this evidence, the Bureau of Agriculture sent me to Siam to study the pomelo on the spot and obtain budwood, plants and fruits.

My first introduction to it in its own home was in the garden of Prince Yugclar, 50 km. northeast of Bangkok, where I met with a type of orchard planting new to me. The trees were all planted on levees, and I soon found that this was the custom not only in

IN A GROVE OF SEEDLESS POMELOS

Part of plantation of Prince Yugelar near Bangkok; foreman of the estate in the foreground. All the trees here shown were supposed to bear seedless fruits, but the third one in the row actually produced pomelos that were excessively seedy. The Siamese strain of seedless pomelos is not very well fixed, apparently, and especially likely to be affected by cross-pollination, but when the fruit is at its best, Mr. Boyle thinks it is probably the best pomelo grown anywhere. A photograph of the seedless pomelo in cross-section was published in the American Breeders' Magazine, IV,4,210, Oct.–Dec., 1913. (Fig. 3.)

Siam, but in many lowland countries in that part of the world. The explanation is that the land has been reclaimed from the sea, by the construction of successive levees about 12 feet wide and six feet high. The space between these is a ditch 12 feet wide and six feet deep, which is used as an irrigation trench, from which water is thrown by men equipped with bamboo paddles, to the trees planted above their heads on the levees. The trees are set about 12 feet apart in the row, the rows being 15 feet apart. The soil is of a very heavy texture, 50% to 60% clay. No cultivation is practiced, other than to keep the levees cleared of weeds.

The pomelos here were inferior to those secured later. Two trees produced pyriform fruits which proved to be absolutely seedless, but on the third tree of the same type in the same row, one fruit out of every half dozen contained seeds. The best fruits which I secured were from Chinese orchards in the Nakon Chaisii district. The largest orchard there contained 48 acres of land, 36 acres being planted with ordinary, seedy pomelos and the remaining 12 acres with trees of the seedless type. The same system of planting was used here as in Prince Yugelar's garden, and the composition of the soil was about the same. All plants are propagated by marcottage, budding being so entirely unknown that the gardeners thought it a practical joke, when shown how to insert buds as the best method of propagation.

I made a thorough investigation of several trees in the seedless section of the grove, cutting open fruits from widely separated points on each tree. All these trees bore seedless fruits, but in some cases seedy fruits were also produced, particularly by trees that stood on the side of the grove nearest the ordinary, seminiferous pomelo trees. The native gardeners believe that the seedlessness of their pomelos is due to the use of salt, a coconut shell full of which is placed around the roots of each tree planted, while brackish water which backs up between the levees is used for irrigation. My own investigation convinced me that we have to do here with genuine seedless types, which however are capable of producing seeds when cross-pollinated. On this theory, the occasional seedy fruits there produced are the result of pollen from trees in the adjoining orchard, carried by the wind or insects to the flowers of the normally seedless trees. The disconcerting behavior of the tree in our greenhouse at Washington, which bore such seedy fruit, is then to be attributed to cross-pollination by some other variety of citrus, of which there were a number in the same greenhouse.

INFLUENCE OF POLLEN.

Due to the shortness of time available for this investigation, I was not able to prove this theory by an investigation of the flowers of the trees in question. But from experience which I gained while working as Assistant in Arboriculture in charge of the propagation of citrus fruits under W. T. Swingle of the U. S. Department of Agriculture at Washington, I am satisfied that this theory fully accounts for the phenomena observed, that it is in accord with our experience on other seedless citrus fruits, and that there is no other theory which will account for the behavior of these pomelos, so simply and comprehensively.

The behavior of navel oranges, in which seeds are very rarely found under normal conditions, seems to me to be an exactly analogous case. E. M. Savage, Assistant Plant Breeder, office of Crop Physiology and Breeding Investigations, who made a large number of crosses of *Citrus trifoliata* on Washington navel oranges in California in 1909, for the purpose of producing new varieties of navel oranges having a frost resistance, tells me that while performing this work in the groves of L. V. W. Brown of Riverside, California, he found a number of navel oranges which bore seeds. These were observed to be growing near pomelo trees, and he believes their seediness was due to the influence of pomelo pollen. Mr. Savage also stated that whenever the navel was from 50 to 100 feet away from the pomelo trees, all of the fruits inspected were found to be seedless.

Similar results were reported in

Florida 20 years ago[1] by H. J. Webber of this Association. He wrote:

"In my experiments, further, a number of navel flowers were crossed with pollen from various other varieties of Citrus fruits. The most notable feature developed in this series of experiments was that in all crossed fruits numerous seeds were produced, while in the fruits produced on the trees normally very few seeds were formed, and in almost all cases none. This commonly seedless character of the navel fruits is, as every one knows, the feature which most recommends this variety of orange.

"In every case where navel fruits developed from crosses, I early marked, nearby on the same tree, young fruits of apparently the same age, and in every way comparable to the crossed fruits other than that they were developed without any treatment whatever as they always naturally do in the groves. They were of course entirely open and may have been pollinated by insects or may have developed without pollination. However this may have been, the fact remains the same that in every fruit thus early marked as checks for comparison, not a single seed was found developed normally. In two or three instances rudimentary seeds about two millimeters long were found.

"The practical suggestion to be derived from the above results is that we should not take means to secure the cross pollination of our navel trees, hoping thereby to secure a larger crop of fruit. The effect of the cross pollination apparently being the production of seedy fruits, but not necessarily more fruits. These are merely suggestions and may have to be modified as more is learned of the subject."

THE SIAMESE OPINION.

In view of this evidence, I have no fear that the Siamese seedless pomelos will not produce seedless fruit, when grown in the Philippines and other tropical countries to which they are adapted. It is interesting to note, however, that all the people in Siam whom I interviewed regarding the seedless quality of the fruit expressed the opinion that it is impossible to get seedless fruits from trees grown anywhere except in the Nakon Chaisii district.

I classified the seedless pomelos of that district in four types, which are quite distinct. In addition to these, there were quite a number of variations in size, shape and flavor, which I tasted in the various orchards. Specimens of all kinds were brought back to Manila, and after 18 days in transit they were in perfect condition. Undoubtedly they will stand long-distance shipment.

Following is a description of the principal characteristics of each of the four types found. It is to be noted that types 2 and 3 are the commonest. Type 4, which is inferior to them, is not very common, while type 1, the finest of all, is quite rare.

Fruit No. 1. Siamese Seedless Pomelo (*Citrus decumana*).

Size: Medium, 4½ inches in diameter by 5 inches in length.
Color: Light yellow skin.
Flesh: White.
Peel: Thin, looser than average, ¼ inch in thickness.
Lenticles: Large and numerous.
Fiber: Delicate; very small amount.
Grain: Standard, loose and fine.
Form: Firm.
Seeds: None.
Taste: Very aromatic; free from bitterness.
Citrus quality proportionate, ideal.
Remarks: In my opinion, the best citrus fruit of the decumana type in existence, both in shape and flavor; excellent for market purposes.

Fruit No. 2. Siamese Seedless Pomelo (*Citrus decumana*).

Size: Medium, 4⅞ inches in diameter by 3¼ inches in length.
Color: Bright yellow.
Flesh: White.
Peel: Good and firm.
Lenticles: Numerous and even.
Grain: Standard.
Seeds: None.
Taste: Citrus quality pronounced; aromatic and excellent.
Remarks: Excellent fruit for market purposes. These fruits are shipped from Siam to Hongkong.

Fruit No. 3. Siamese Seedless Pomelo (*Citrus decumana*).

Size: Medium, 4½ inches in diameter by 5⅛ inches in length.
Form: Pyriform.
Color: Orange yellow.
Flesh: Pinkish white.
Peel: Medium; about average.
Lenticles: Firm.
Fiber: Medium.
Core: Large.
Grain: Loose.
Seeds: None.
Taste: Aromatic; rather heavy. Good.

[1] Webber, H. J., 1894. Results in Crossing Navel Oranges, in Proc. Florida State Horticultural Soc. Seventh Ann. Meeting, pp. 62-64. Jacksonville (Tallahassee, Fla. Floridian Pr. Co.).

Remarks: A fair fruit for market purposes, but such pomelos as Marsh Seedless are superior.

Fruit No. 4. Siamese Seedless Pomelo (*Citrus decumana*).

Size: Very large.
Color: Yellow.
Flesh: Deep pink.
Peel: Thick; more than average.
Lenticles: Large and numerous.
Fiber: More than average.
Grain: Small and firm.
Seeds: None.
Taste: Bitter.
Citrus quality proportionately poor.

NEW PUBLICATIONS

Die Züchtung der landwirtschaftlichen Kulturpflanzen, von C. Fruwirth. Band V, Die Züchtung kolonialer Gewächse. PP. viii, 184. Berlin, Paul Parey, 1912. Price, M.10.

This volume of Dr. Fruwirth's encyclopedic work on plant breeding treats in detail of the most important plants cultivated in German's colonial possessions—namely, sugar cane, rice, millet, coffee, cacao, citrus species, cotton and other fiber plants, yams, manioc, peanuts, olives, sesame and the oil palm. Each culture is in effect, monographed by a specialist, Dr. Fruwirth himself being responsible for only a few of the contributions. The book, like all those that Dr. Fruwirth has produced, covers a field not adequately treated by anyone else, and covers it in a way that leaves little to be desired. It is technical in scope, but to genetists who are interested in tropical products from a practical point of view, it should be almost invaluable.

Breeding Australian Opossums

That the Australian opossum (*Trichosurus vulpicula*) might be bred in the United States with profitable results is the belief expressed in a communication from B. Harrison of Burringbar, N.S.W. The name "opossum" applied to this species is almost a misnomer, since he is widely different from the North American animals to which it properly belongs. The Australian opossum is a nocturnal, arboreal animal, living on eucalyptus leaves, tender shoots, and such fodder. He is easily domesticated, and takes kindly to a diet of grain and fruit. His thick and wooly fur commands a ready sale, while the flesh is excellent, particularly if the animal has been fattened on corn. The black Tasmanian opossum yields a still more valuable fur, but Mr. Harrison thinks that either one could be bred easily and successfully in most parts of the United States.

Standards for Graphs

With a view to standardizing the methods of constructing graphs in use by men of science in the United States, so that their construction and interpretation may be simple and uniform, and their use therefore more widespread and popular, the American Society of Mechanical Engineers has taken the lead in the formation of a Joint Committee, to consider the whole subject and make suitable recommendations. As biological as well as physical sciences are now widely interested in the use of graphs, the A.S.M.E. has asked the president of the American Genetic Association to appoint one member of the Joint Committee to represent this association. Charles B. Davenport of Cold Spring Harbor, Long Island, N. Y., has been named to act in this capacity.

ORIGIN OF KARAKUL SHEEP

Black Danadar the Original Fur-bearing Stock of Central Asia—This Crossed with White, Fine-wool Afghan Sheep Produced the Gray Danadar Which in Turn Crossed with Fatrump Sheep Produced the Small Arabi or Karakul Breed—Industry in Turkestan Being Ruined by Natives.

Dr. C. C. Young
Charlottetown, Prince Edward Island, Canada.

SOME 26 years ago Dr. Sinitzin, who was at the time employed by the Russian government in Tauria as senior animal husbandman, made a trip to Bokhara in Russian Turkestan and, while there, made an effort to describe the various breeds of sheep that produce valuable lamb skins. Up to that time no attempt had been made by anyone to classify these breeds, and practically nothing had been written on the subject save for the brief mention made by Pallas in his book, in which he so ably described some of the other Asiatic breeds of sheep. It is Sinitzin who first learned that the word *Kara Kul* ("black lake"), was a term not employed by the natives, but that the Russians who came prior to him to Bokhara in quest of fur-bearing sheep, and who were in the habit of making their purchases in the Kara Kul district near the village of the same name, situated near the railway station, on a small river, both of which also bear the name, had transferred this geographical name to the sheep.

It was also Dr. Sinitzin who first gave the world the terms used by the natives in designating certain breeds of fur-bearing sheep: Arabi, Duzbai, Shiraz, and so on. Although he made several grave errors in his classification, he nevertheless deserves credit for having done a large amount of valuable pioneer work.

Dr. Sinitzin describes (1) the small Arabi, (2), the large Arabi, (3), the Duzbai, (4), the Shiraz and (5), the Zigai, among the Bokharan breeds of sheep. He names the small Arabi as the origin of all the fur-bearing sheep of Central Asia, including the Malitch of Crimea, the Tshushka of Bessarabia and the Reshetilev and Sokoliev of Poltova province. According to this theory, the small Arabi is descended from the Mamai, the oldest breed of domesticated sheep, petrified specimens of which, dating back some 8000 years, were found by Duerst in excavating the ruins of Anau (Transcaspia). Sinitzin resorts to the Bible for further history and claims that Jacob won Rachel by knowing how to breed the pigmented sheep that are the pride of the Sarts even today.

But as all Karakul breeds are broadtails (*Ovis platyura*), and as the petrified sheep above mentioned proved to be a fatrump (*Ovis steatopyga*), Dr. Sinitzin's theory can not be taken very seriously. My own experience has shown me that when a longtail sheep is crossed with a fatrump, the result is a broadtail, and while the first cross looks more like a typical Russian fattail (called by the Russians *Jirnochvostaja*), the second and third crosses can not be classified otherwise than as broadtails. I therefore concluded that the Karakul breeds resulted from crosses of longtail sheep on fatrumps. I have often found Karakul sheep, closely answering Sinitzin's description of the Small Arabi, which had rather long tails with so little fat accumulation at the base that the tail resembled that of a longtail sheep, rather than that of a broadtail.

THE TEST OF PIGMENT.

In all these cases that came under my observation, I found that the black pigment in the wool of the *mature* sheep

did *not* oxidize into gray, as is the case with the Arabi *and also with the Duzbai*, so that the specimens in question remained black. I therefore concluded that the small Arabi was a hybrid (and not a very well fixed type of hybrid at that) and that some *black longtail sheep* (the blackest of all black sheep on earth) played an important part in the formation of the breed. Needless to say, I did not exclude the presence of a fatrump admixture—otherwise, how could the small Arabi be a broadtail?

The presence of fatrump blood was easily traced in the Duzbai, which has the long, pendulous, drooping ears that characterize *Ovis steatopyga*, the convex nose line, large head, very thick feet, enormous weight, and a tail with fat accumulation that weighs as much as the kurdiuk (fat sack) of a fatrump. As Duzbai lambs frequently come fawn (the natural color of the fatrump), it is easy to understand why the fatrump's anatomical characteristics appear so dominant in the Duzbai breeds. If a small, black, longtail sheep is crossed with an enormous fawn one (both fixed types), Mendel's law leads us to expect that the offspring will have the characteristics of the latter.

I explained in a former paper[1] that I received most valuable information from the oldest fur dealer in Bokhara, Karavan Bashi Aziz, to whom I was introduced by F. N. Petrov, dragoman of the Russian embassy at New Bokhara. From this gray-haired, honest Musulman I learned that some 60 years ago there were no Arabi nor Duzbai sheep in Bokhara, but at that time the only fur-bearing sheep which produced beautiful, pea-like, tight, lustrous, black curls, was the black *longtail* Danadar. It was not my good fortune to see one of these sheep during my extensive travels in Bokhara in 1912 and 1913, and as I have already explained, the photographs sent me by Mr. Petrov were not sufficient to convince me that the breed really existed at the present day. This spring I was more fortunate and thanks to the Vice-Emir, who provided me with an intelligent guide (Abdul Hamid Bek Mirza Bashi, an officer high in the Emir's employ) I was able to see the only herd of gray Danadar sheep which still exists in the Khanate of Bokhara.

About 100 miles from Old Bokhara city (the capital of the Khanate) there is the district of Kejumek, where we were received by the qazi (the highest judge of the district) who introduced us to a very old sheep breeder of the district, one Kana Abdsiu, who pastured his father's herds of black Danadars and also had his own herd. His grandfather, he said, raised "dogtail" Danadars, and he not only corroborated the story given by the Karavan Bashi Aziz, but added still more interesting information, stating that as the demand began to increase for black Danadar lamb skins (after Bokhara was conquered by Russia in 1865) the natives began to cross their black sheep with white, fine-wool Afghans. This in time produced the *gray Danadar* breed, lambs of which produced skins with small, gray curls the size of pinheads, rather open and lustreless. One such skin is now in my possession. This injection of white blood, contaminated with fatrump blood, in time changed the black Danadar into the small Arabi. The cross of the black Danadar on the fatrump breeds produced the Duzbai. The gray Shiraz evolved from the gray Danadar, and possesses larger curls and more lustre than the gray Danadar, because of its fatrump admixture. The Zigai is a typically Russian breed that never existed in Central Asia, and if Sinitzin saw any there, it must have been because they were taken there by Russian Tartars who settled in Turkestan. Sinitzin's large Arabi, according to Karpov, who wrote the Russian government bulletin on Karakul sheep in 1910, is the same animal as the Duzbai, and I certainly agree with him.

INFLUENCE OF THE DANADAR.

We know now that the black Danadar is to the sheep family what the negro is to the species *Homo sapiens*. There can be no doubt that the Tshushka and

[1] Young, Dr. C. C. Breeding Karakul Sheep. Journal of Heredity, V, 4, 170, April, 1914. See also Strange Sheep of Asiatic Russia, American Breeders' Magazine, IV, 4, 184, Oct.-Dec., 1913, and ibid., third quarter, 1912.

Sokoliev (both longtails) are also descended from it. The Luk-Nakbo breed of Tibet[2] is also closely related to the black Danadar; so is the black Gadik of Afghanistan, some few of which are still found between Mazar-i-Sherif and Kabul. I financed an expedition to Afghanistan this spring and hoped to get photographs illustrating the rare and valuable breeds of that region, as some supposedly trusted Turkomen living in Afghanistan near the Bokharan border town of Kerki on the Amur river had obligated themselves to bring two ewes and two rams (Gadiks) to Kerki, where they were to be turned over to the governor, who promised to ship them on camels to Karshi, where I patiently awaited them. Alas! as there are no honest Turkomen on earth, I lost my money.

As foreigners are forbidden entrance to the military towns of Kushk, Takhtibazar, Kerki, Kelif, Termez and Sarai, on the northern border of Afghanistan, and as I could not get a Russian passport (to which my birth entitles me) without sacrificing my American citizenship, I was again forbidden entrance to those cities, which hold so much of interest to the traveler as well as the sheepman. I did indeed risk arrest for espionage by visiting Kerki, where I obtained an excellent Karakul ram. I was conveyed from Karshi to Kerki in an American Ford automobile, and have some interesting photographs showing how we were pulled out of the drifting sand by camels at several points on the route. Returning, we paid dear for having forsaken the faithful camel, as we nearly perished from thirst.

The ministry of foreign affairs having refused me permission to take any Karakul sheep out of Bokhara for exportation to the United States this year, I have started an experimental farm in Bessarabia, on the estate of Michael Alexevitch Stamatov. During a campaign of four and one-half months I secured 66 head of Karakul sheep from the districts of Karshi, Kerki, Gissar, Tjarjui, Burdalik and Karakul. As I explained in a former paper, the few Karakul sheep in European Russia, which might be secured for export, are all inbred and most of them crossed with Afghan blood to such an extent as to make them worthless. In Bokhara, the Karakul breeds are hastening toward extinction, thanks to the senseless methods of the native breeders, who kill all good lambs and, besides, continually infuse finewool blood from Afghanistan. I am trying to get the Emir of Bokhara to take radical measures to save the industry, and, with the backing of the American and British embassies and Professor Wallace of the University of Edinburgh, have already won the cordial support of the governor-general of Turkestan and the Russian ambassador at New Bokhara. It is highly desirable, however, that these fur-bearing sheep should become established on a reasonably large scale in the United States, by the introduction of reliable stock.[3]

[2] I wish to express my thanks to His Eminence the Chambo Jorje, ambassador of the Dalai Lama, who while visiting the Czar at St. Petersburg kindly received me and furnished me with much valuable information about this valuable fur-bearing member of the black Danadar family.

[3] This communication was forwarded from Karshi, Bokhara, under date of June 1, 1914, Dr. Young later succeeding in exporting 28 sheep which are now in quarantine near Baltimore, Md. —The Editor.

ALFALFA HYBRIDIZATION

Attempt to Improve Plant by Breeding for Better Seed Production and Grazing Qualities—Success in Crossing with the Black Medick—Segregation in the Offspring—Importance of Insects in Pollinating Flowers.

William Southworth

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FEW forage crops are better known than *Medicago sativa* L.—alfalfa, lucerne or purple medick. It is, perhaps, partly because it is so well known that so little has been done to improve it by scientific breeding.

Its chief value to farmers on the North American continent lies in its capacity to produce large crops of nutritious forage, cut to feed green or made into hay. The crop is occasionally grazed by cattle and sheep, but most practical men agree in the opinion frequently expressed that our present commercial strains are not well adapted for grazing: if the crop is so treated it rapidly loses root and quickly dies out.

Another serious defect in our existing strains of alfalfa, very marked in some districts, is the lack of capacity to produce seed freely. As one of the great essentials of a farm crop is power to produce an abundant supply of seed, it will be readily understood that the shy seeding habit of alfalfa in some districts is a serious drawback to its general utility.

Thus, despite the immense economic value of our present-day strains of alfalfa, there are at least two lines in which their improvement or modification might be undertaken with advantage, viz:

(1). To obtain a strain having the capacity to set seed more freely under a greater variety of soil, climatic, and other environmental conditions.

(2). To obtain a variety which will be better adapted for grazing.

The first part of the problem might be solved by simple selection. Unfortunately, all the types which seem to offer possibilities for grazing appear to be below the average in the capacity to produce seed. Hence it seems unlikely that a complete solution of the problem could be expected by following a course of selection no matter how perfectly the system might be conducted; consequently it was decided to test what success could be accomplished by crossing the alfalfa with another suitable plant in the same genus. The plant which seemed to fulfil most of the conditions required is the common yellow trefoil, otherwise known as black medick (*Medicago lupulina* L.).

THE BLACK MEDICK.

This plant may be described as having slender stems, mostly prostrate, frequently lying flat on the surface of the land; it produces an abundance of fine leaves and these together with the soft and succulent stems yield good grazing but not good hay.

In the United States and in Canada it is usually looked upon as a weed, but in Great Britain and some other European countries it is sown largely for use as a grazing crop and is considered to be well adapted to sheep pastures on dry, upland, chalky and limestone soils. Black medick is only a temporary plant, not lasting more than two years, but is a prolific producer of seed.

As compared with black medick alfalfa may, in general, be called upright in growth, stems fairly stout, bearing many leaves; it is well adapted for cutting for hay and yields heavy crops of rich fodder but is not suited for grazing. It has a very deep root system, is strictly perennial, but under some conditions does not seed very freely.

The general form of the alfalfa flower and the manner in which pollination is

effected have been known for many years. A. P. deCandolle described them in 1832; since then the subject has been investigated by F. Hildebrand, I. Urban, Hermann Müller, Sir John Lubbock, I. H. Burkhill, C. V. Piper and others. There is such a want of harmony in the published results of these investigations, however, that local conditions seem to play an important part in them. Hence each worker must find out what actually takes place under his own environmental conditions, if he expects to achieve success in alfalfa breeding.

To this end experiments were commenced in 1911 at Ontario Agricultural College, and are still in progress. Their aim is the practical one of breeding better strains of alfalfa, rather than the elucidation of any points of merely theoretical interest.

Preliminary experiments were arranged to obtain information on the following points:

(1). When alfalfa is in flower what effect, if any, has the exclusion of bees and other insects on seed production?

(2). If alfalfa flowers be self-pollinated by hand and insects excluded are they sterile or fertile?

(3). If it is the case that insects are essential to ensure fertilization, what species appear to be most successful in performing this operation?

POLLINATION BY INSECTS.

The answer to the first question concerning the exclusion of bees or other insects was of a most decisive character. The results showed that in not one case was a single seed produced when bees were prevented from gaining access to the flowers. Tests were continued throughout a second season with the same results; hence we feel confident in concluding that, in the climatic and environmental conditions under which the tests were conducted, alfalfa flowers are incapable of becoming fertilized when insects are prevented gaining access to the flowers.

With reference to the second question it was found that though alfalfa flowers are protected from the visits of insects, yet if they be self-fertilized by hand a fair percentage of the blossoms produce seed: thus proving that the plants are not self-sterile.

As regards the third question the answer is less simple.

No attempt was made to record all the species of insects which visited the flowers. Various butterflies are very commonly found but apparently they are of no value whatsoever in bringing about fertilization of the flowers. After extended observations it was concluded that the common honey bees are the most numerous visitants, but much to our surprise it was found they have the power to extract the nectar from the flower without liberating the stamens and pistil from the keel. The flower is left intact; consequently no fertilization takes place. In the course of observations extending over three seasons only one case has been seen where a honey bee liberated the stamens from the keel of an alfalfa flower and in this particular instance the bee was enclosed in a cage containing the flower.

The bumble bee is fairly active in fertilizing the flowers; a species of Andrena is apparently very useful, too. But a variety of wild bee belonging to the Megachile group was found to be much more effective than all other insects combined. This bee goes to work as if it enjoyed the task, and as it will pollinate from eight to twelve flowers a minute it will be readily seen that a single bee may visit several thousands of flowers per day.

From the results of our observations and tests we may conclude:

(1). From the structure and mechanism of the alfalfa flower it is incapable of self-fertilization if it is not interfered with by external agencies, natural or artificial.

If, however, the stamens and pistil be liberated by suitable artificial means the flower is capable of producing seeds; hence it is not self-sterile.

(2). In nature certain wild bees are most effective in liberating the stamens and pistil, hence when there is scarcity of these bees a very small percentage of flowers are pollinated, the result being a great dearth in the production of seed.

Reasoning from the above observations and experiments we venture to suggest that the shy seeding of alfalfa

THE BLACK MEDICK

This common weed (*Medicago lupulina*) is a rather distant relative of the alfalfa or lucerne (*Medicago sativa*). It is prolific bearer of seed, and also possesses good grazing properties. As ordinary commercial strains of alfalfa are weak in just these two points, there seems reason to believe that a cross with the black medick might lead to the production of a much improved strain of alfalfa. The breeding of such a strain has been taken up by Ontario Agricultural College, with apparently good chances of success. (Fig. 4.)

in certain districts is due to the lack of fertilization of flowers owing to a scarcity of suitable insects to carry out the necessary operation of liberating stamens and pistil from the keel.

BLACK MEDICK SELF-FERTILIZED.

As previously stated, the black medick is frequently regarded as a weed, and most farmers and botanists are well acquainted with its marked capacity to produce seed no matter whether the season is favorable or otherwise. This capacity to seed freely under varied climatic conditions is doubtless owing to its being apparently normally self-fertilized and not requiring the aid of bees or other external agency to ensure pollination.

This property which black medick possesses of producing seed from self-fertilized flowers was investigated by Darwin and in his "List of plants fertile without insect aid," dealing with *Medicago lupulina*, he gives the results of his experiments as follows:

"On account of the danger of losing the seeds, I was forced to gather the seeds before they were quite ripe; 150 flower heads on plants visited by bees yielded pods weighing 101 grains whilst 150 heads on protected plants yielded pods weighing 77 grains. The inequality would probably have been greater if the mature seeds could have been all safely collected and compared."[1]

In recording the results of his own observations made in 1894–5 Burkhill describes[2] the form and mechanism of the flowers of black medick as being similar to that of the common lucerne, but in the flowers of the former plant the stamens and pistil are much more easily liberated from the keel.

In regard to seed-production, Burkhill found that where flowers of black medick were left exposed to the visits of insects 95% produced seed, when enclosed in a net 75% of the flowers set seed.

In the course of our tests (not knowing of any previous investigations having been made on this subject) we enclosed the flowers of black medick in a muslin cage similar to that used for alfalfa flowers.

The object of the test was simply to see whether or not the black medick flowers would produce seed when bees and other insects were excluded. It was found that the protected flowers set seed apparently almost as well as those which were fully exposed. No attempt was made to make an exact count of seeds or pods obtained by the two methods as so many of the pods were lost on ripening it was not possible to make a comparison which would have been strictly accurate.

The above tests all indicate that in black medick we have a plant in which the free seeding propensities are developed to a high degree of perfection. This property, I need scarcely say, is of immense value as a rapid and easy means of reproduction and is a characteristic which if it can be successfully combined with our present strains of alfalfa will so enormously enhance their usefulness that the increase in the value of the crop as a whole can not be well estimated.

THE BREEDER'S PROBLEM.

Having arrived at this point our problem will now be clearly seen as being:

(1). An attempt on the one hand to combine the high crop-producing properties of alfalfa with the free seeding propensities of black medick.

(2). To try to effect a suitable combination between the hardiness of alfalfa and the fine growth of foliage and valuable grazing properties of black medick with a view to the development of a plant suitable for pasture purposes.

The first alfalfa mother plants to be used were selected from individuals from strains originally obtained from the United States Department of Agriculture, Washington.

The work was commenced in June, 1911, and carried on throughout the

[1] Darwin, Charles. The Effects of Cross Fertilization in the Vegetable Kingdom, p. 368. New York, 1877.

[2] Burkhill, I. H. On the Fertilization of Some Species of Medicago, L., in England. Proc. Camb. Phil. Soc., Vol. 8, p. 142, 1892-1895.

FIRST GENERATION OF THE CROSS

At the right is one of the hybrid plants produced by the cross of the black medick on alfalfa. It was numbered A6, and its flowers self-fertilized. From this selfed seed was produced the F_2 generation. In this second generation a considerable amount of segregation took place. In the first generation there was much variation, even between plants raised from seeds in the same pod. The plant shown at the left is a young shoot (Fig. 5.)

months of June and July until the middle of August without a single cross setting seed.

Owing to the hot and dry weather the flowers faded and dried in such a short time that great difficulty was experienced in obtaining sufficient flowers in a suitable condition for the purpose of hybridization.

Under such circumstances, in order to continue the tests it was found necessary to use any alfalfa plant, no matter to what strain it belonged, provided it was bearing healthy and vigorous flowers. While searching for such plants I found one growing in an adjoining discarded grass plot; it possessed a rich green foliage with an abundance of healthy, vigorous, violet flowers. A number of these flowers were emasculated and crossed with pollen from black medick which was obtained from the flowers of various plants growing as weeds in the vicinity.

From these crosses five healthy pods were obtained, the seed from which was sown in the fall of 1912, 24 plants being raised. The plants were kept in the greenhouse until the following year, when 19 were removed to the open field, the remaining five being planted out in July. These latter plants not having been treated uniformly with the rest have not been included in the present records.

In order to distinguish between the various pods they were designated by letters A, B, C, D, E. The number of seeds per pod varied from three to seven and in sowing, the seeds from the respective pods were numbered consecutively and kept separate throughout.

With two exceptions all the 19 plants grew vigorously and as they increased in size showed considerable variation; it was also very noticeable that plants produced from different seeds out of the same pod varied in quite a remarkable manner.

DIFFERENCES IN HABIT.

On referring to the photographs, it will be seen that some plants were tall with slender flexible branches whilst others were quite dwarf in habit with stout rigid branches and carrying a dense mass of leaves. During the period of growth it was observed that in several plants the young shoots which arose from the bases of the rootstocks were a very light pale yellow tint, in some cases almost white in appearance; but when the shoots became older they gradually assumed a darker tinge and finally turned to the normal green color of the rest of the foliage. It was seen, also, that the young seed pods of these plants were of a light salmon pink color which changed to brown as the pods became ripe.

As regards flower color, all the plants produced variegated flowers and the tints varied on almost every plant. The chief color was violet shading into purple; dark purple, and green. In some flowers the edges of the keel were lined with yellow but in no case was yellow seen on the wings or standard.

On most plants the flower structure was quite normal and required the usual operation to cause tripping to take place. Two plants were noticed which produced a number of abnormal flowers.

In structure these abnormal flowers had an enlarged keel which presented a swollen, unhealthy appearance, but contained the usual number of stamens enclosed. The pistil, however, did not remain enclosed in the keel as in the normal alfalfa flower but pushed its way out and the stigma in the form of a hook could be seen standing erect quite clear of the keel and fully exposed. In these abnormal flowers the standard was also much reduced in size and the whole raceme of abnormal flowers presented a very curious aspect.

By the above description it will be readily understood that it would not be necessary to trip such flowers to liberate the pistil.

These abnormal flowers were kept under close observation during the summer and as several produced seeds they were collected separately for the purpose of further experiment.

In view of the fact that these plants were raised under artificial conditions and that at the stage of growth as described previously they had only been planted in the open about three months, it is not thought advisable at this stage to give a detailed description of the different parts of the plants and their variations, but a table is here given setting forth some of the main characteristics noticed.

The measurements given in the table were taken from average individual shoots from the respective plants and it is from these same shoots that the accompanying photographs were prepared.

From plants of the first generation self-fertilized seed was obtained. One plant, C2, grew more vigorously and flowered much more profusely than any of the rest and as it yielded a fair amount of well-developed selfed seed this was sown in order to make a study of the second generation.

SECOND HYBRID GENERATION.

These plants were raised in the autumn of 1913 in the greenhouse laboratory of the Department of Plant-

Table showing some of the principal vegetative characteristics of the plants in the first hybrid generation.

Plant	Average height of plant, inches	Character of stem	Remarks on leaves
A_3	14	Thin slender	Many uniformly distributed.
A_4	11	Almost rigid	Medium in number.
A_5	15½	Thin slender	Not numerous.
A_6	7½	Rigid	Very many.
A_7	20½	Very thin slender	Very small, not numerous.
B_2	12½	Almost rigid	Numerous.
B_3	15	Medium	Many densely crowded above.
B_5	12½	Medium	Not numerous.
B_6	14¾	Similar to B_3.	
C_2	23	Thin slender	Few sparsely scattered.
C_3	6½	Rigid	Many densely crowded.
C_4	18½	Stout not rigid	Medium in number.
D_2	14¾	Not rigid	Resembles C_4.
D_3	10½	Almost rigid	Not numerous.
D_4	9½	Rigid	Many densely crowded.
E_2	7	Rigid	Similar to D_4.
E_3	8½	Almost rigid	Many uniformly distributed.

breeding, Cornell University, by the following methods.

The seed was first sprouted in small earthenware pans kept in a corn germinator. As the seeds sprouted they were at once removed and planted in 2½-inch pots containing ordinary potting loam.

During the process of germination, after the seeds had been several days in the germinator at a temperature around 70° F., those seeds which still remained hard and dormant were treated by immersing them for 10 minutes in strong commercial sulfuric acid; the seeds were then washed free from acid and replaced in the germinator. This treatment usually caused them to sprout in one or two days.

In the case of some few seeds which were exceptionally hard a second 10-minute immersion in sulfuric acid was necessary to render the seed coat sufficiently soft to allow germination to take place. For a knowledge of this method of inducing germination in hard seeds I am indebted to H. H. Love,[3] Professor of Plant-breeding Investigations at Cornell University.

By the adoption of the method described above a practically perfect germination was obtained; hence the system can be strongly recommended as being well adapted for dealing successfully with one of the difficulties a plant breeder has frequently to encounter: viz., the task of inducing germination in hard seeds which do not readily respond to ordinary methods of treatment.

These plants have been raised and grown under artificial conditions exclusively and at the time of writing are not yet at their full growth and not in the flowering stage. It is not my purpose to enter into a full discussion as to whether or not there is any strict Mendelian segregation of characters; however, in order that whatever information has been obtained may be made readily available for future reference it has been thought advisable to place on record the results of observations made.

HEIGHT OF PLANT.

Taking first the character of "height of plant" it was found there was a range of from two to eleven inches, the increase from the shortest to the tallest being fairly regular (see fig. 6). There was no evidence of discontinuity between Talls and Dwarfs which might be looked for where segregation is in strict accord with Mendelian principles, hence a difficulty in dealing with this question

[3] Love, H. H. and Leighty, C. E. Germination of Seed as Affected by Sulfuric Acid Treatment. Cornell University, Dept. of Plant Breeding, Bul. 312, 1912.

SECOND GENERATION PLANTS

These plants represent types of the produce of the seeds from (C2), one of the first generation hybrids. The wide range of variation in height and habit of growth is strikingly shown. Although this variation was continuous, it was found, when the plants were divided in two groups, one of which (the erect) contained all plants above the mean, and the other (the non-erect) all plants below the mean, that these two groups closely approximated the expected Mendelian proportions, in their relative frequency. (Fig. 6.)

of height is to determine the exact point at which the plants should be divided on the one hand into Talls and on the other hand into Dwarfs.

After some consideration it was decided to take the mid-point of the measurements as the dividing line between Talls and Dwarfs; for example, any plants exactly half-way between the tallest plant and zero should be classed as Dwarf, while those having a greater height measurement than the mid-point should be placed in the Tall class.

When the plants were measured their average heights were found to vary from two inches up to eleven inches. Then taking the mid-point at 5.5 inches all plants which measured up to this height inclusive were placed in the Dwarf class; those above 5.5 inches being placed in the Tall class.

On analyzing the measurements it was found that the plants arranged themselves in the following manner:

Segregation of plants according to height.

	Found		Calculated	
	No. of plants	Ratio	No. of plants	Ratio
Tall plants all exceeding 5.5 inches in height..........................	78	2.6	81	3.
Dwarf plants 5.5 inches in height and under..........................	30	1.	27	1.
Totals.....	108		108	

If we accept the arbitrary standard of measurement used for grouping the Talls and Dwarfs, it will be seen that in view of the small number of plants studied the actual segregation is fairly close to theoretical expectancy, the Tall character being dominant and the Dwarf character recessive.

HABIT OF GROWTH.

A reliable determination as to whether there is any segregation in habit of growth is even more difficult to obtain than in the case of height; and as no simple measurements can be made to be of use, any determinations for purposes of classification must be made by observation.

A close inspection of the plants showed that as with height the variation in habit of growth was continuous. Beginning with the prostrate form as characteristic of black medick there was found to be a continuous series ranging through decumbent and semi-erect up to the erect form; this latter habit resembling the female parental form (alfalfa).

In order to resolve a continuous series of this kind into two groups the method was adopted of first classifying the plants into four subdivisions, then arranging the subdivisions into two main groups by which means the plants fall naturally into one of two groups one of which has been termed non-erect and the other erect, as shown in table below:

Segregation of habit of growth

Prostrate forms..	3 plants	non-erect 88.
Decumbent..	85 plants	
Semi-erect..	12 plants	erect 20.
Erect..	8 plants	

As will be seen by the above the prostrate and decumbent forms have been classed together as non-erect and the semi-erect and erect make up the other group, each group containing a series of forms.

Comparing the actual results with the calculated we have the following:

	Found		Calculated	
	No. of plants	Ratio	No. of plants	Ratio
Non-erect form	88	4.4	81	3.
Erect	20	1.	27	1.
Totals	108		108	

Reasoning on the basis of the above system of classification we have here also a strong suggestion of Mendelian segregation, the non-erect forms being dominant and the erect recessive.

For reasons already indicated I do not consider this study as furnishing conclusive evidence in support of the points under investigation, and it is proposed to remove the plants into the open field and after a more prolonged study under natural conditions to present a further statement which it is hoped may be more exhaustive and on which we may look with a greater degree of confidence than is possible at the present stage of the enquiry.

SUMMARY OF CONCLUSIONS.

1. There is need for a strain of alfalfa having superior properties to any at present in cultivation, especially in its power to produce seed freely under a great variety of conditions.
2. Alfalfa apparently does not seed freely in absence of suitable insects to insure fertilization of the flowers.
3. Wild bees of the Megachile species seem to be most effective in insuring fertilization.
4. Alfalfa flowers are not self-sterile and may be artificially self-fertilized with good results.
5. Black medick is capable of self-fertilization and produces seed freely even when insects are prevented gaining access to the flowers.
6. In the practice of hybridization of alfalfa better results are obtained by working on mature flowers than by operating on flower buds.
7. The cross between alfalfa and black medick is effected only with considerable difficulty and prolonged effort is essential to warrant success.
8. In the F_1 Generation hybrids the plants were variable and usually greatly different from either of the parental forms.
9. A study of the progeny of F_2 Generation revealed a tendency to Mendelian segregation both in height of plant and habit of growth, but further study is necessary to confirm these points.
10. The difficulty often experienced of inducing germination in hard alfalfa seeds may be successfully overcome by treating them with strong commercial sulfuric acid.

CONSTRUCTIVE EUGENICS

Agreement of Views of Lecturers, Starting From Diverse Viewpoints, Indicates That Scope and Methods of Science of Eugenics are Now Largely Fixed, and That Concrete Constructive Advance Through Education is Practicable.

A Review by The Editor.

THE publication of these lectures on eugenics,[1] delivered in 12 different universities last year, is significant—not because they contribute anything new to science but because they show that it is a science, with well understood bounds, and aims and methods on which its adherents agree, no matter how far apart their viewpoints are. Eugenics may not yet be an "exact science"; perhaps it never can be: but the day when each eugenist was a law to himself is passed. Its scope and, to a large extent, its methods, are now as well defined as those of any other of the sciences.

The lectures here printed, together with others on the same subject, were delivered in different American universities, through the initiative of Mrs. Huntington Wilson of Washington, D.C. As is to be expected, their appearance in book form entails a good deal of repetition of subject matter, since they are nearly all general in character. This is not a serious defect, however, and it is decidedly interesting to note just which points seem to have appealed strongly to all those interested in the propaganda. The variety given by the different viewpoints of the lecturers, who represent biology, sociology, economics, psychology and medicine, adds to the interest of a perusal of the book, and emphasizes strongly the point which the Journal of Heredity is attempting to demonstrate, that whatever the viewpoint and whatever the methods by which the problem of eugenics is approached, the problem is always the same.

It is, further, of particular interest to note that the constructive side of eugenics is emphasized by each of the lecturers. It is possible that this was a condition made when the lectures were arranged. In any event, it is an encouraging feature, for it indicates that the time is past when serious consideration can be claimed by a so-called eugenics whose sole ambition is to do negative work. Negative or restrictive eugenics is given ample attention in the book, as it deserves, but none of the lecturers assumes for an instant that purely negative work will solve the problem of race betterment. That, it seems to me, represents a decided advance which the science of eugenics has made during the past few years.

ACTION PRACTICABLE.

There seems to be a widespread misunderstanding as to the extent to which negative and positive eugenics are respectively practicable at the present time. Professor Bateson has recently issued this warning:

"It is evident that while the elimination of the hopelessly unfit is a reason-

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[1] Eugenics: Twelve University Lectures. Pp. xiii+348. New York, Dodd, Mead & Co., 1914. Price $2, net. Contents: Foreword by Lewellys F. Barker; The Eugenics Program and Progress in its Achievement, by Charles B. Davenport; Eugenics as viewed by a Zoologist, by Robert H. Wolcott; Eugenics from the Point of View of a Physician, by Victor C. Vaughan; Eugenics as Viewed by the Physiologist, by W. H. Howell; Eugenics: its Data, Scope and Promise, as Seen by the Anatomist, by Harvey Ernest Jordan; Eugenics from the Point of View of the Geneticist, by Herbert John Webber; The First Law of Character-Making, by Arthur Holmes; The Eugenics Movement from the Standpoint of Sociology, by Charles A. Ellwood; Eugenics and its Social Limitations, by Albert Galloway Keller; Selections from an Address on Eugenics, by William Herbert Carruth; Eugenics and Economics, by Morton A. Aldrich; Eugenics: with Special Reference to Intellect and Character, by Edward L. Thorndike.

able and prudent policy for society to adopt, any attempt to distinguish certain strains as superior and to give special encouragement to them would probably fail to accomplish the object proposed." . . . "It must suffice to point out that whereas our experience of what constitute the extremes of unfitness is fairly realizable and definite, we have but little to guide us in estimating the qualities for which society has or may have a use, or the numerical proportions in which they may be required."

Few will disagree with these judgments; yet they must not be interpreted too broadly. We can indeed segregate the feebleminded and epileptic, but that gives no warrant for so-called "eugenic legislation" restricting marriage, as Professor Bateson himself has vigorously pointed out on many occasions. On the other side, it is true that we can not yet breed intelligently for many definite points of social value; and yet it seems to me that all are agreed on certain fundamental principles which make constructive eugenics entirely feasible. Galton himself laid down the principle that the most important thing to breed for was energy; to this we may add good health, longevity, intellect and morality; for few will be found to deny that these characters form desirable attributes, and that they are heritable, even though we can not show the exact method of their inheritance.

This alone, it seems to me, constitutes ample warrant for all rational attempts to forward the constructive side of eugenics, and we can reinforce it by the proof, now abundant, that the effects of even the best environment are slight in comparison with the effects of these inherited forces—or the lack of them.

Evidently the 13 contributors to the book under consideration hold much the same views. Each one thinks the hope of the future is in influencing marriage selection by the force—conscious or unconscious—of public opinion. Dr. Barker seems to strike the keynote of the whole book when, in the introduction, he declares, "the cultivation of a healthy public opinion regarding marriage and parenthood will, it seems probable, be more efficient in promoting eugenics than anything that can be done by way of legislation, at any rate at present."

LIMITATIONS OF ACTION.

This, in substance, is the mode which all of the lecturers, from their diverse standpoints, agree in accepting as the practicable mode of procedure. There is no suggestion of breeding a superior race under live-stock conditions, as the lay press too frequently assumes to be the ideal of eugenists; indeed, as Dr. Carruth emphatically remarks, "The only extensive positive impulses to breeding given under civilization, so far as I can discover, have been the breeding of negroes and hybrids for slaves, the breeding of women for concubines in oriental countries, and the subsidizing of the breeding of men for cannon-food in various great imperial countries."

One after another, the lecturers arrive at the same position. None has a panacea to propose, but each one believes—and many give convincing reasons for their belief—that public sentiment can be so enlightened as to produce the ends which eugenists seek, without further measures. "Society may choose to breed from the bottom," as Dr. Thorndike puts it, "but it does not have to."

Dr. Howell, in common with nearly all of the speakers, holds close to the lines laid down by Galton.

"So long as we hold to our good custom of founding marriage mainly on affection and mutual attractiveness," he suggests, "it is a difficult and delicate matter to influence the direction that fancy may take. Mr. Galton looked at the subject in a practical and sensible way. He calls attention to the fact that it is our custom to allow many considerations to play a minor part in this question of selecting one's partner for life—considerations of race, or religion, of occupation, of financial standing, etc., etc., and what he hoped for was, that as a result of general education in regard to the influence of heredity, eugenical considerations may also take their part among those factors whose additive influence determines the choice that is made. This is a moderate and conservative suggestion, but quite suffi-

cient to give point to an educational propaganda. It is likely in the long run to prove wiser and more beneficial than an advocacy of more radical measures. In spirit and intent it accords very well with the advice of the wise and experienced in such matters at all times. 'Marry only for love,' said William Penn, 'but be sure that thou lovest what is lovely.' This sage aphorism may be interpreted to mean that we should so cultivate our appreciation of what is best in humanity as to be attracted only by those who possess desirable qualities. I fancy that this state of things is what positive eugenics hopes to accomplish or aid in accomplishing; not by force, not even by deliberate persuasion, but by bringing to the consciousness of educated people a realization of the fact that the welfare of the next generation will be influenced by the way they marry, as well as by the way they live."

PENSIONS FOR MOTHERS.

Dr. Ellwood dicsusses and dismisses a number of proposals that have been made in the line of positive eugenics. Pensions to mothers and mothers' compensation do not appeal to him as desirable. "Are we going to put every service which individuals render to society upon a money basis?", he asks, "or are there not some services which we can not pay adequately for with money, and which we should not attempt to pay for with money, because it degrades them? Is not parenthood such a service? Would not the women who would accept compensation for motherhood be the very sort of women whom we might least desire to be mothers?

"We must, then," he concludes, "give up for the present, at least, the idea of the encouragement of parenthood in any material way. The whole question, therefore, of positive eugenics reduces itself at once to the question of the ideals of life which we should encourage in the young. It, therefore, becomes primarily a matter of education rather than legislation.

"This means, of course, that young men and women must, even at a very early age, be given right ideals of marriage and parenthood. If they are to make a more reasonable selection of mates, not only must the widest acquaintance between young people be encouraged by society, but they must also be given somewhat different standards of selection than most of them have at the present time. The ideals of good manners, social popularity, good looks, and wealth, must be replaced with the ideals of health, intellectual ability, and moral character. When these latter qualities come to be put first in the mutual choice of the sexes in marriage, there can be no doubt that the benefit to society will be incalculable."

Dr. Keller takes his stand squarely on the basis laid down by Galton. The latter hoped that eugenics would be "introduced into the national conscience like a new religion;" Dr. Keller recognizes the possibliity of such an event as being a proper field for the sociologist, and discusses it at length and interestingly. It is easy enough to talk about it; the question is, can society really control one of the strongest passions for its own purposes? Has it been able to do so in the past? He points to the taboos that have been in force at one time and another: taboos on consanguineous marriages, on exogamy, on endogamy, on polygamy; in some cases, indeed, effective taboos on all marriage, as with priests. Nor need we stop with primitive peoples, nor with the restraint of one passion alone.

EFFECTIVE TABOOS.

"Consider the case of the Hebrews in respect to the food taboo, and the taboo upon unions within certain degrees of blood-kinship. Consider the strength of the taboos lurking in present-day conventions respecting, say, the eating of human flesh or the marriage of the closest kin. If the same distaste were to forbid non-eugenic unions which exists to prevent the eating of the flesh of cats, the aim of the eugenists would be in large part attained." Or, to take a more frivolous and recent case, Dr. Keller mentions the former vogue of knee-length golf trousers, and the complete disappearance of them in the United States at present. "There is now a taboo—perfectly irrational in almost every respect—upon this style

of clothing. If non-eugenic unions should become as infrequent for a dozen years as golf trousers have been for that time, the eugenists could point to a golden era."

It is, then, evident that the goal of the eugenist is capable of attainment. "How can this be done? Or, to put it more concretely, how can unfortunate unions be effectively tabooed, as incest is tabooed?"

"All fruitful agitation for change must confine its aspirations within discreet limits. It must enlist sentiment, if it can, rather than reason; and the great compelling sentiment is fear. . . . Further, fear must be brought home. Some men are able to fear and worry for the far generations of mankind, but not many of us can get up much excitement over the fate of even our great grandchildren. Fear must be brought *home*, I say; and to the individual." Dr. Keller therefore urges that the knowledge of the laws of heredity be made widespread, and that physicians in particular be more active in making known the noxious action of some of the "counterselective factors" that are injuring the race.

Dr. Aldrich also expresses the problem in a concrete way. "How far is it possible," he asks, "for a body of thoughtful men, with an earnest conviction of the value of their eugenic teaching, to influence the formation and growth of a public opinion powerful enough to encourage parenthood of the fit and discourage parenthood of the unfit?" He would not belittle the difficulties of the task; but neither would he have them appear more insurmountable than they really are.

"When we consider the few years since the beginning of any systematic and wide-spread eugenic effort, and the difficulties in the way, the striking fact is that so much has already been achieved. . . . I do not think that any observer of American life will disagree with me when I say that there is already a marked tendency among the young men and young women of this country to look more carefully than they used to do to the physical and mental fitness of those whom they choose as their husbands or wives."

Dr. Wolcott emphasizes the need of "the conservation of desirable germ plasm by preventing the loss of manhood due to war, by enlarging individual opportunity, and educating the public to the desirability of more care in the selection of mates. Increased individual opportunity may be secured by subsidizing the fit, by a higher scale of wages, by a decrease in the cost of living, and by the removal of social hindrances to marriage such as the increasing demands of professional and business life. The methods of procedure last outlined again carry us over into the field of euthenics, which we have seen from so many points of view lying close to that of eugenics."

ALLIANCE WITH EUTHENICS.

Dr. Jordan, too, points out in a vigorous way the tremendous reversal of natural selection which is caused by war. He suggests the endowment of parentage, but believes the scheme must be safeguarded with many checks and qualifications. He looks to the church as a potent factor in the educational compaign to create the eugenic conscience which he hopes to see the public acquire.

Dr. Webber, recognizing the need for encouraging parentage among the superior, also recognizes the need for better standards or methods of judging ability early in life. As an aid to the development of the race he urges "the great importance of establishing an adequate system of human registration similar to that used in the registration of pure bred stock.

"Such a human registration would serve many useful functions. First and primarily, it would stimulate pride in family and the desire on the part of any individual whose ancestors were in the register to measure up to or surpass that standard. I believe that family pride is the most potent influence in restraining the individual from error, and in stimulating him to greater effort.

"Such a register would include only good and superior individuals, as mediocre or poor grade individuals would never seek to be included in such a pedigree record.

"Once started I believe such a regis-

tration would be sought by all of the best individuals of society and soon it would come to be almost universal among good families having pride or confidence in their ancestry. Soon, if one is not registered or his family is not registered, the question would arise, why are they not registered? In this way I believe all individuals and families that have not very serious defects in their pedigrees would be led to register, and thus the object would be accomplished, as we could then be certain that unregistered families could not be considered good constructive eugenic material.

A GUIDE TO MARRIAGE.

"Such a register would have great value, doubtless, as a guide to marriage. Suppose a father notices a growing intimacy between his daughter and a young man of apparently good character but of unknown ancestry. The registration number of the young man's father or mother could be obtained and from this, for a small fee, the girl's father could secure a brief outline of the young man's family history. If this history were bad doubtless it would serve to check any growing intimacy between the two and would save the family much trouble and worry."

Dr. Davenport makes clear one feature of the program which some of the other lecturers implied rather than directly stated. "It is not sufficient to secure good matings and cut off the bad," he points out. "The eugenic marriages must be fecund, and must equal or exceed the fecundity of the cacogenic matings. No fact is more startling today, and fraught with greater danger to the commonwealth, than the low fecundity of our best blood.

"From 1193 bachelors of arts of Bryn Mawr college since 1888 there have been produced to January, 1913, 263 girls all told. Twenty years after graduation, close to the reproductive limit, 328 graduates of Harvard in my class have reproduced 195 sons to take their place. An earlier class of 278 persons, 25 years after graduation, had produced 141 sons, or had only about one-half reproduced itself; and no account is made of infant deaths. Assuming that a class produces half as many sons as it graduates, and that their descendants do the same for six generations, 1000 Harvard graduates of the 1880's will have 16 male descendants of the 2080's. These 16 sons will be ruled by the scores of thousands of descendants of 1000 of the Rumanians, Bulgarians, Greeks and Hybrid Portuguese of the 1880's. Such figures must make one fear for the future." He therefore advocates examination of the family history of immigrants, in order to reject those who are manifestly undesirable breeding stock.

Summing up his own paper, he says: "Thus the program of eugenics stands; first, investigation; then, as knowledge grows, education. Finally, legislation based on sound public sentiment. For the carrying out of this program the public is quite ready and indeed waiting. It is seeking to be wisely led."

NEGRO-UTE METIS

ABOVE—NEGRO-UTE HALF-BLOODS. BELOW—PURE-BLOOD UTES

The accompanying photographs were taken by the writer at the time of a visit, in April, 1910, to the Southern Ute reservation in southwestern Colorado, in the company of John P. Harrington of the School of American Archeology at Santa Fe, New Mexico. The picture of greatest anthropological interest is the upper one, portraying, as it does, a not very common instance (in that region, at least) of race mixture. The boy and girl are brother and sister, children of a Negro father and full-blood Ute mother. They live on the farm allotted by the government to the mother. The Negro characters are most apparent. Some features, however, especially the hair, show Indian influence. The hair, particularly that of the girl, recalls a type found among many of the Oceanic blacks. The skin has the distinctively Negro chocolate color. For comparison, I present, below it, the picture of two typical Ute girls. The four children are of about the same age, and were all pupils in the day-school a few miles north of Ignacio agency.—Albert N. Gilbertson (University of Minnesota, Minneapolis, Minn.), in American Anthropologist, n. s., 15, p. 363, (1913). (Fig. 7.)

HIGH ALTITUDE MAIZE

The above photograph (Fig. 8) shows a stalk of one variety of my acclimatized corn with its product. I have been making an effort to get a stalk of corn of which the aggregate ear-length would equal the entire length of the main stalk, and I think I will finally succeed. Since high altitude, low temperature and lack of humidity decrease all vegetal factors but do not effect reproductive virility, the environment is favorable to this effort. The specimen is a hybrid from unidentified parents, both of which have been grown at an altitude of over 7,000 feet for quite a number of years. It has been cross-bred with several varieties with a view of increasing the forage, but did not succeed until mated with sweet-corn—the forage was then increased 75 to 100%. I am sure that by this process a valuable corn for silos in dry farming districts can be produced.

The length of stalk shown is 50 inches.

Aggregate ear-length 43 inches.

Two ears,	12 rows per ear,	46 grains per row:	1104	grains.
One ear,	12 rows per ear,	40 grains per row:	480	grains.
One ear,	12 rows per ear,	34 grains per row:	408	grains.
On suckers:				
Two ears,	10 rows per ear,	28 grains per row:	560	grains.
One ear,	8 rows per ear,	15 grains per row:	120	grains.
Total number of grains of corn on plant - -			2672	

A. JAY GARRISON.

Edgewater, Colorado.

RACIAL HYBRIDIZATION

Studies of the Offspring of Boers and Hottentots—Mendel's Law Seen in the Inheritance of Many Characters—Racial "Prepotency" Not Found to Exist—Mankind a Single Species.

Eugen Fischer[1]

THE author has taken in hand a problem that leads him into wholly new fields, which hitherto have hardly been worked—the investigation of a hybrid race. The material is the most valuable he could have selected, the mongrels of Rehoboth, the product of miscegenation between Boers and Hottentots. The physical anthropology of these hybrids, especially all phases of it that concern race mixtures, naturally makes up the most valuable part of the book.

The racial mixture here is not such as we usually find, the result of irregular unions which produce a racial proletariat that defies all anthropological analysis. We have, instead, a well-defined race of mixed ancestry, with definite, fixed characteristics; we can measure the proportions of each stock which it contains. It is a mixture that has risen to the rank of a new race.

When, in the eighteenth century, Dutch and Low German peasants penetrated the country, defence against their common enemy, the Bushmen, brought them into close contact with the Hottentots. Of course, there were few European women in that raw land, given over to nomads and hunters. Consequently, we find many half-blood children, of Hottentot mothers and Boer fathers. The primitive life of a Boer "on trek" was not very different from that of the aborigines; consequently, it is not surprising that a great many of the Boers took Hottentot maidens in life-long marriage. The racial pride of the pure Boer families thrust out these results of mesalliance; but the mulatto sons also partook of the racial pride of their fathers, and married girls of the same origin as themselves—not caring to marry pure Hottentots and not being able to obtain white wives. We thus find at the present day hybrids of two degrees.

HOLLANDERS PREDOMINATE.

Family traditions, particularly among the older generations, have extraordinary vitality, so that the genealogies claimed by various branches of a family are in entire agreement. Of the 27 men who are recognized as founders of mixed families, 17 are Hollanders, 11 Germans, and nine of unknown origin. Other European men came later, taking Hottentot girls in marriage; occasionally there is a birth outside of wedlock. On the whole, these European founders of families are preponderatingly Low German; it may be added that the nordic race preponderates.

The female ancestry is somewhat easier to analyze, for no other women than Hottentots are mentioned. Occasionally, however, there is no doubt that a Boer married a Damara or Herero girl.

The material which Fischer used, with great skill, consists of 310 men, women and children, studied anthropologically, and 300 additional cases studied through photographs. The author divides his material into three groups. One group of hybrids continue to marry *inter se*—these he calls "middle" hybrids. Opposed to them are two

[1]Fischer, Eugen. Die Rehobother Bastards und das Bastardierungsproblem beim Menschen: Anthropologische und ethnographische Studien am Rehobother Bastardvolk in Deutsch-Sudwest-Africa. Jena (G. Fischer) 1913 Translation and abridgment of a review by Mollison of Heidelberg in the Zeitschrift für Morphologie und Anthropologie, Stuttgart, 1913; Bd. XVI, Heft 2, page 397.

other groups, "crossed out" with Europeans and Hottentots respectively. Pure European blood was always introduced by a man, pure Hottentot blood by a woman. In the individuals of the last two groups, the proportion of the two stocks represented is diverse. The most extreme grade is the result of direct outcrossing, such as is given, for instance, through the marriage of the son of a European with a girl of mixed origin of the first generation. The three groups are briefly designated as the Eu-group, mid-group and Hott-group, according as one or the other blood, or neither, preponderated. As a "control" group for comparisons in his measurements, Fischer took peasants of Baden, there being no available observations on Hollanders. The only comparative measurements on pure Hottentots were those made by Fischer himself, on eight men and seven women.

The stature of the mongrel men (average 168.4 cm.) is considerably greater than that of the Hottentots (157.9 cm.) and even somewhat above that of present-day Hollanders (167.5 cm.) or of the South Germans (167-168 cm.). The women are much shorter than the men, the difference of about 11 cm. being about the same as with the population of Baden, while among the Hottentots the difference between the sexes seems to be somewhat less. The mean of the Eu-group is 174, that of the mid-group 167, and that of the Hott-group 168 cm. for the men, or 160-157-157 for the women.

WOMEN BECOME OBESE.

The women show the same tendency to lay on fat which characterizes the Hottentot women; the men do not have this tendency. It begins to show itself from the fifteenth to seventeenth years and reaches its maximum at the age of 30. This may be due to environment rather than to heredity.

The form of the skull is understandable as a combination of that of the Hottentot and European forms; but the skulls of the Eu-group are notably nearer to those of Europeans and those of the Hott-group to the skull-form of the pure Hottentot.

The facial appearance is decidedly variable. Measurements show that the hybrids mostly are intermediate between pure forms of the two races. The nose is never either entirely European or entirely Hottentot.

A test showed that the individuals of the three groups could be accurately distinguished by their general appearance.

The skin of the hybrids is dry and little turgescent, as with Europeans. In color it is tolerably light—portions of the body which are covered with clothes show a lighter tint than that of the skin of the Mediterranean race. Many individuals have a darker tint, but it is seldom a pronounced brown. The frequency of lighter and darker skins follows rather closely the degree of racial-mixture. The hair form is extremely variable, ranging from smooth to very curly. Its color is usually black. That of the children is usually lighter, whereas Hottentot children show black hair from its first appearance. Fischer leans to the belief that when hair darkens in adult life, it always indicates racial-fusion somewhere in the ancestry of the individual concerned.

Light eyes are much more frequent in the Eu-group than in the Hott-group, and in one instance pure blue eyes are found; the mid-group holds an intermediate place in this connection. It is notable that wholly dark eyes are rarely found even in the Hott-group.

MENDELIAN COMPUTATIONS.

The second and most important part of the book deals with the results that an investigation of these hybrids offers to our knowledge of the laws of heredity. The prevalence of Mendel's law naturally occupies the most important position, preceded by an analysis of the unit characters.

The relative frequency of straight and waved hair is found, in the second generation of the mid-group, to be about that expected by Mendel's law; 18% smooth and 82% curly, as compared with the 25% and 75% expected from theoretical calculation. The proportions of straight hair with the Eu-group (48%) and the Hott-group (17%) are also comprehen-

sible on the same formula. By back crossing of equal degree with Europeans and Hottentots, the whole population must be the equivalent of an F2 generation, that is, one-fourth straight-haired and three-fourths wavy-haired. The reality (71:228) accords satisfactorily with this expectation. Davenport's discovery is also confirmed, that the hair-form Mendelizes with the formation of an intermediate type in the heterozygotes, among whom straight hair is recessive and curly hair dominant.

The figures for light and dark eyes also accord with the Mendelian expectation demonstrated by G. and C. Davenport and Hurst.

It is evident that the relative breadth of the skull follows Mendel's law; and none of the other dimensions of the face seem to be inherited in an intermediate stage.

The appearance of the eye also closely conforms to the Mendelian expectation, 25% being oblique and 75% level. The proportion in single families is close enough to these figures to be considered confirmatory.

The small, high form of nose seems to dominate the low, broad one. The feminine appearance of the faces of the mongrels seems to be due to the independent inheritance of unit characters.

Proof that the investigator's views as to dominants and recessives are well founded, is furnished by the first generation hybrids—that is, the product of marriages between white men and Hottentot women. Fischer could not find many such children, but an examination of those whom he did discover satisfied him that the theoretical expectation was fulfilled; as did the results of crossing back, between mongrels and either one of the parent races.

ONE LAW FOR ALL LIVING CREATURES.

He is thus convinced that for a long list of characters the mechanism of heredity is the same when races of mankind are crossed as when breeds of livestock and varieties of plants are hybridized.

The increased stature of the hybrids is probably explainable through the well-known vigor resulting from crossing, although it can not always be determined that such a result is not due to the environment. Perhaps the vitality and low death-rate of the hybrids is explainable on the latter basis, since it is in decided contrast to the observed result in other cases (for example, the mulattoes resulting from a cross of English and negroes), where the power of resistance seems to be lowered by the cross. At present we can not account for the fact observed by Hagen among Tamil-Malay metis, and by Fischer among the subjects of the present book, that the countenances of the hybrids are longer than those of either parent race. It is possible that we are justified in suspecting a correlation with the increased bodily vigor.

The fecundity of the hybrids appears not in the least to be diminished. It does not seem possible to pass dogmatic judgment on the fecundity of racial crosses in general. It is only certain that all races are fertile with each other, that the hybrids are fertile with either one of the parent races—although it is questionable still whether the fertility may not be diminished; that the hybrids are fertile *inter se*, although in many cases the fecundity seems to be diminished; and finally, that the factors on which this result depends, are unknown to us.

Another chapter takes up the question whether a new race can be formed through crossing. The first generation hybrids are certainly not a new race, but merely a patch-work of characteristics inherited from their parents. But in a later generation appearances are very different. As the unit characters are separately inherited, the chance for a given individual to inherit all or most of those of one of the parental races becomes steadily smaller. The characteristics of the parent races, therefore, are still present after any number of generations, but the resemblance of individuals to either parent race has become less (excluding, for the moment, all questions about the influence of environment). When a hybrid population has once become established it therefore remains con-

stant with respect to the inheritable anthropological characters.

THE IDEA OF PREPOTENCY.

The hazy conception of a "prepotency" in transmission is referred by Fischer to its most plausible origin, the accidental combination of numerous dominant characters. He tests the question of whether there is a racial prepotency by means of curves, which show the genealogically middle-group to hold exactly a middle ground between its two parent races. He therefore concludes: "A prepotency of either of the parent races, a stronger tendency of the hybrids to resemble either one of them, does not exist. On the average the hybrids occupy an exactly intermediate position. One can not talk safely of a prepotency." An apparent preponderant influence of any race in transmission merely indicates that it possesses many characters which behave as dominants.

Mathematical computations failed to discover any correlation of the characters shown by hybrids; in consequence it must be assumed that the characters of the two parent races act entirely independently in heredity.

Consanguineous marriages are very frequent among the hybrids. No evil results have ever been noticed from them, but an increased sharpness of family types is produced.

As the end-product of hybridization, Fischer does not admit the formation of a new race, since that would require blended inheritance of at least a number of important characteristics. From his views on heredity, he concludes that mankind as it exists today forms but a single biological species.

Mme. Montessori's View

The most interesting biological researches of today are in regard to the hereditary transmission of characteristics.—Maria Montessori.

PRIZES OFFERED FOR PHOTOGRAPHS OF LARGE TREES

TWO prizes of $100 each are offered for photographs of large, wild, native trees in the United States, by two members of the American Genetic Association, who are interested in forestry and wish to secure data along somewhat novel lines. These prizes are to be awarded as follows:

One hundred dollars for photographs of the largest nut-bearing tree. This includes chestnuts, oaks, walnuts, butternuts, pecans, etc.

One hundred dollars for photographs of the largest shade or forest tree, not nut-bearing. This includes such trees as the elm, beech, poplar, tulip-poplar ("yellow poplar" or "tulip tree"), etc.

Photographs of conifers will not be considered.

All photographs must be submitted to the JOURNAL OF HEREDITY before July 1, 1915, and will become the property of the Association. Photographs must be taken by or under the direction of those who send them in, and not purchased from professionals or collections. Competition is not confined to members of the American Genetic Association, but is open to the public.

It is hoped that a collection of photographs, such as should result from the offer of these prizes, will furnish some reliable information about the maximum size attained by North American trees, and the regions and conditions under which they attain their greatest development. It is further hoped that seed or other material from the largest specimens may be used for propagation. In order to make these offers yield the necessary information, contestants should comply with the following conditions:

Photographs must be on glossy paper, not smaller than 4 x 5 or 3¼ x 5½ inches, and must be of sufficient excellence to allow reproduction in the JOURNAL OF HEREDITY or elsewhere. Photographs in which the tree is so small that its details can not be made out, can not be considered. As much information as possible should be furnished about the tree in question, and exact identification is particularly necessary. For this reason the photographer should send a branch with leaves and, if possible, flowers or nuts, in order that the Association may identify it. The measurement of the tree must be given in detail. In making it the only method which may be followed is to take the circumference of the trunk at five feet from the ground. The trunk must not be measured at a point where its girth is increased by the juncture of a branch; if it is so swelled at a point five feet from the ground, the measurement should be made at the smallest diameter above the basal swell and below the swell of the branches. In such a case the fact should be stated when the photograph is sent, and the exact point at which the measurement is made should be indicated. It is desirable that the full height of the tree and spread of branches, as well as the girth, should be stated; if they cannot be measured exactly, they should be estimated. Photographs should, when possible, contain some object, such as a human figure, or a horse and buggy, which will aid in giving a realization of the size of the tree; but such figure should be beside, not in front of the tree. It is necessary that one photograph should include the whole tree. If there are other trees growing beside it and cutting off part of it these other trees should be included in the picture. A second photograph of the same tree should be sent in, showing the trunk only, with a little foreground. Each contestant is thus required to send in two photographs of the same tree, one showing the entire tree and the other the trunk only. Contestants may send photographs of as many different trees as they like.

With each photograph, a statement should be submitted telling all that is known about the tree, with reference to its age, its fertility, the quality of the nuts (if it bears nuts); the character of the soil and surrounding vegetation. It is particularly necessary that photographers should state whether there are many other very large trees of the same species in the neighborhood—within a radius, say, of five miles. If the tree is on private land, and likely to be destroyed, the fact should be mentioned. If there are any historical or literary associations connected with it, these should also be mentioned. It will be helpful if photographers can tell to what extent the tree is subject to attacks by disease or insects. In short, the council desires to gain as much information as possible about the largest trees of the United States; but it imposes as few hard-and-fast restrictions as possible, because of the varying conditions under which photographs may have to be taken, or under which they have been taken at some time in the past.

It is immaterial whether the tree is shown with full summer foliage, or defoliated in winter condition.

The council will be glad to furnish information on any problem connected with these offers; it will judge the photographs submitted, and reserves right to decide any disputed points. Only the two capital prizes will be given, but all other noteworthy trees will be mentioned in the final report. The prizes are offered by Mr. Charles Deering of Chicago and Mr. W. A. Wadsworth of Geneseo, N. Y.

The Human Breed.

To be a good animal is the first requisite to success in life, and to be a nation of good animals is the first condition of national prosperity.—Herbert Spencer.

Men are commonly more careful of the breed of their horses and dogs than of their children.—William Penn.

The Journal of Heredity

(Formerly the American Breeders' Magazine)

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Date of issue of this number, October 25, 1914.

DESCENDANTS OF THE EUROPEAN UR OR AUROCHS

Young Chillingham Park cattle, lately presented to the Royal Zoological Society, London. They are considered to be nearly direct descendants of the now extinct European wild ox, which was still found in isolated localities until three or four centuries ago. These Chillingham cattle are semi-albinoes; dark calves appear from time to time and are weeded out. They show a remarkable diminution in size from that of the ur (*Bos taurus primigenius*), due, Darwin thought, to the inbreeding to which they have been subjected for centuries. That this inbreeding has not resulted more disastrously to the stock is probably accounted for by the stringent selection, through combats for supremacy among the males. Photograph from Paul Thompson. (Frontispiece.)

ARYAN AGRICULTURE

Most Important Plant and Animal Products of Europe Indigenous—Wheat and Barley Cultivated 50,000 or More Years Ago—Horse the Latest of the Important Animals to be Domesticated—Origin of the Plow.[1]

PRIVATDOZENT DR. DETTWEILER

Inspector of Animal Husbandry, Rostock in Mecklenburg, Germany.

UP TO quite recently, it would hardly have been possible to write on the theme I have chosen today, "The Beginn ngs of Agriculture and Animal Husbandry among the Indo-Germans." For it used to be taken for granted that Europe with its Indo-German population received all its culture from Rome and Greece, or from the Babylonian Orient, and so it was quite useless to concern one's self over such a problem as I have just stated. The northern European population passed for raw, ignorant, wholly uncivilized—in a word, they were barbarians, to whom the higher civilization of the south and east first brought the light of progress. Nay, not only was the culture supposed to have been imported from the outside, but the population itself was held to have immigrated from Asia.

On all these questions the last two or three decades have caused many reversals of position. Just as natural science is today based on the idea of evolution, so has the idea gradually gained ground that the population of Europe developed independently on its own ground with its own culture—more, that these have an antiquity surpassing anything we know of Babylon or Egypt. Today it is admitted—except by a few—that the original home of the primitive European population, the Indo-Germans, is not Asia but Northern Europe, that they developed their culture there in the late Stone Age, and that they then dispersed in their wanderings to the south and east, as far as India. I can not now enter into the details of this question. I must ask you simply to accept it as a fact, that the standpoint above sketched is the correct one. According to it the coast of the East Sea, perhaps with Mecklenburg as its central point, is to be considered the original home of the Indo-Germans. But even here, they were *immigrants* at a relatively late day, and perhaps are merely descendants of the people of the Stone Age, who lived during the Glacial Period in southern France and Spain, perhaps also on the northern coast of Africa. In this connection it must not be forgotten that during the Ice Age the climate in that region was milder—that is, cooler—than it is at present. It was only after the ice had melted away in our latitude that man ventured into the north.

CROPS OF THE LAKE-DWELLERS.

In order to have some secure standpoint from which to handle our none too simple data, it seems necessary to take a definite cross-section of history, and I shall therefore take the so-called Age of the Lake-dwellings. It is fairly known, even in details, is remote enough to be included in the prehistoric period, and yet has been so thoroughly investigated that one can form a tolerably clear picture of it. Its culture belongs to the so-called Neolithic or later Stone Age, extending perhaps up into the Bronze Age, that is, about 2000 to 4000 years before Christ.

I shall limit myself to a consideration of the agriculture of this period.

[1] Address delivered before the Dozentenverein of Rostock; translated (and slightly abridged) from the Illustrierte Landwirtschaftliche Zeitung, 32 Jahrgang, No. 81, p. 745, Berlin, 9 Oktober, 1912.

The lake-dwellers of Switzerland cultivated, according to Braungart, the following kinds of plants:

1. The short-eared, six-rowed barley, *Hordeum sanctum* of the ancients, which was grown in the Alps up to recent times.
2. The thick-eared, six-rowed barley, *Hordeum hexastichon* L., var. *densum*, with large ears and kernels.
3. Two-rowed barley, *Hordeum distichon*.
4. Small lake-dwelling wheat, *Triticum vulgare antiquorum*.
5. The true Binkel wheat, *Triticum vulgare compactum*, which is even today grown in isolated localities in the Alps.
6. Egyptian or English wheat, *Triticum turgidum*, L. It is today widespread in many varieties.
7. Emmer, *Triticum amylium*, Seringe, T. *dicoccum*, Sch., a thick-eared, awnless, unique species, grown in its original form in the Tyrol as late as 40 years ago, but seeming now to have changed.
8. One-grained wheat or Einkorn, *Triticum monococcum*, L., grown in the transition period between the Stone and Bronze Ages, perhaps along with spelt (*Triticum spelta*, L.). Today it is grown only in scattered regions of the Tyrol.
9. Meadow (common), millet, *Panicum miliaceum*, L.
10. Club millet, *Panicum italicum*, L.
11. Flax, not that known today (*Linum usitatissimum*), but the type which still grows wild in Greece, *L. angustifolium*, L.

Far from these lake dwellings, in the little village of Gleichberg, near Römhild, at the southern edge of the Thuringian forest, under a wall 10 meters high on an old fireplace, there was uncovered in 1906 an important find, with remains of the oldest Bronze Age, which contained the following:

1. Einkorn wheat. 2. Spelt, which is grown there even to this day. 3. Binkel wheat. 4. Small lake-dwelling wheat. 5. Small lake-dwelling barley. 6. The smallest (Celtic) type of vetch (*Vicia faba*, L., var. *altica nana*, Heer.) 7. Peas, *Pisum sativum*. 8. Poppy, *Papaver somniferum*, var, *antiquum* Exceptionally large seeds, apparently cultivated. 9. Apple seeds (?).

That *Triticum turgidum* was lacking, is explained by the climate.

PROOFS OF HIGH CULTURE.

At various points in Württemberg (at Gross Pretach near Heilbronn and at Heutingsheim near Ludwigsburg) whole villages belonging to the late Stone Age have been excavated and have shown a high degree of culture—that is, well developed agriculture and animal husbandry. There can no longer be any doubt that a well-directed search would unearth many more proofs of active life in the prehistoric period in that region. That they are still lacking is explained by the newness of the idea and the little endeavor that has been made to confirm it. We have much better information about the early years of the peoples of Asia, wholly unrelated to us, than we have about our own predecessors in Germany.

But the data already accumulated show this at least, that in the later Stone Age a rather highly developed culture with the cultivation of food plants and the keeping of domestic animals, existed. But where did it come from? Its mere existence does not prove that it grew up on the soil, and is not an Asiatic importation.

To get such proof, we must go still farther back and explore the Paleolithic or old Stone Age.

The early discoveries showed us a great gap—the so-called *Hiatus*—between old and new Stone Ages, which favored the theory that the population had entirely changed in that period, because no signs of transition could be found. Later discoveries have revealed the transition. The number of those who have rejected the idea of a change in the population, and have insisted on a persistent evolution of the same stock, is therefore augmented. Each day, almost, brings more evidence to their support, and it seems as if the time is not far distant when the gap will be closed.

Nevertheless, in the field that interests us—agriculture—there is a great gap still. For while the men of the new Stone Age had almost all our present-

WILD AND CULTIVATED WHEAT

At the left, seeds of the wild wheat of Palestine, which is thought by some authors to represent the ancestral form of the present cultivated wheats. In the center is a large-seeded variation of this wild wheat, which was produced at Bard, California; on the right is shown, for comparison, seeds of the Sonora wheat, the one ordinarily grown in the southwest United States at the present day. The Palestinian wheat (*Triticum hermonis*) has adaptations for cross-pollination, whereas the cultivated varieties at present depend almost invariably on self-fertilization. Photograph from O. F. Cook, enlarged about one-fourth. (Fig. 1.)

day domestic animals, our most important field products and—as we shall soon see—our farm implements, the men of the old Stone Age had as domestic animals at most the dog and perhaps the reindeer, and among garden products had only two or—if you like—three kinds: barley and wheat, but the latter in two forms—*Triticum polonicum*, L., which is still cultivated at the present day in the Spanish province of Galicia, and owes its name to a geographical error of Linnaeus; and spelt.

Recent discoveries have thrown valuable light on the upper middle Paleolithic age, the Age of Reindeer. They come from caves in the Pyrenees mountains near Lourdes, and consist of carvings on reindeer horns, unmistakable in their execution. Further, in the cave of Lorthet, belonging to a late part of the same epoch, there was found a carving on slate, which depicted winter barley such as is even yet grown in that locality.

Means of preparing food at that period have not yet been found. Perhaps people ate their grains roasted. This condition exists throughout the transition period from the old to the new Stone Age; and from that period barley and wheat grains have been found, not only in southern France, but also in the mounds of mussel shells along the coast of Denmark.

I want to make it plain that in the Paleolithic age—that is, some 50,000 years ago—man must have had some kind of an art of agriculture. That he must have possessed a relatively high degree of culture is demonstrated by the wonderful fidelity to nature shown in his engravings on cavern walls.

Whether his cultivation of cereals was done with a hoe, as we cultivate garden-stuff, or whether it was done in some other manner, is a question of secondary importance. The point of real importance is that in such a relatively distant period there was any agriculture at all.

ORIGIN OF CULTIVATED WHEAT.

Where did his plants come from?

It is evident that the men of the old Stone Age must have made use of plants that grew wild around them, whose seeds or fruits they gathered, and whose value was generally known. Such ancestral forms have been definitely identified, in our time, only in Palestine, where about 30 years ago

Koernicke of Poppelsdorf found wild forms of wheat and barley. Lately Aaronsohn has confirmed these discoveries.[2] The two forms look remarkably alike, and Braungart thought he had discovered, in Alpine mutations, the transitions between them. Aside from that, North Africa yields an indigenous wild barley. Apparently the ancestral home of this plant is in the Mediterranean region, a fact that bears witness to the antiquity of its culture and the close connections between the Paleolithic cave men and the Indo-Germans.

Rye and oats can not be found with certainty until the Bronze Age. Whence the rye came is an unsolved question. Hirt thinks, as a result of certain indications, that rye was known to the Indo-Germans even earlier than this. Oats are European in their origin, and in the form of the so-called wild or "fly" oats are a common weed.

Studies in comparative philology have, according to Hoops, shown that the Indo-Germans had names *in common*, for the following things and ideas relating to agriculture: among cereals, barley, spelt, wheat and millet (this appears to be the third oldest crop, thus presupposing a culture in high antiquity); grains, garden bed, couch-grass (*Triticum repens*), rye-grass (as a weed). Chaff, furrow, arable land, scythe, sickel. Broom. Meal, to grind in a mortar, to pound, to grind between stones, millstone, handmill, mill.

Of these words "furrow" and "garden bed" extend only into the Armenian; the others are common, and must therefore have been the property of the original population before its first great separation. They give the starting point for an evaluation of the primitive culture. Gardening with a hoe must at that time have been outgrown; we find ourselves in the presence of a real agriculture—otherwise words for plow, furrow and arable land would not have been in use. Everything points back to a time much more remote than we have been accustomed to take into consideration.

Flax, peas, beans, potherbs, are later acquisitions, like rye and oats.

Barley seems to have been the earliest crop; barleycorns were used as measures of weight and length by the primitive Indo-German peoples.

The question at once presents itself, whether the agricultural implements and skill of the Indo-Germans offer a means of determining at what period their separation took place. Braungart has attempted to solve this question, and seems to me to have succeeded.

EVOLUTION OF THE PLOW.

He reviews, in a long and acute work, all the agricultural implements which he has seen either in the original or in model or picture, and reaches the following conclusions:

1. The hand implements, and the hand-plow evolved from them, are of Indo-German origin, and must have been developed before the emigration to Asia of the multitudes which later figure as Persians, Iranians and Hindus; for all the branches of the race use the same type.

The oldest example is usually considered to be the plow found on the moor of Doestrup in Jütland, although the plow from the cliff near Bohuslän in Sweden may be older. The Doestrup plow is in that case neolithic. The so-called Hesiod plow from Greece is much more recent—about the ninth or tenth century B. C.

This type, which developed from the spade, consists in its oldest form of three parts, and in this form exists even to the present day in various localities. The well-known "hook" of Mecklenburg and the instrument known at Cologne as a "wessel" or Huns plow,[3] still in use today, are undoubtedly derived, in part, from the primitive spade-plow, and can show a neolithic ancestor in the plow found at Dabergotz, near Berlin. This indeed shows the typical

[2] See Cook, O. F. Wild Wheat in Palestine, U. S. Department of Agriculture, Bureau of Plant Industry, Bull. No. 274, Washington, 1913.

[3] So called because it was supposed to have been introduced by the Huns.

VARIATION OF WILD WHEAT

This large seeded "sport" of the Palestinian wild wheat appeared in cultivation at Bard, California. It is here shown natural size. The head at the right shows in a striking way the fragile nature of the articulations in this wild wheat—a character that is also found in wild oats and other grains. In the struggle for existence in nature, such fragile articulations are an advantage to the plant, for they enable its seeds to be more readily disseminated; under cultivation, however, they are a distinct disadvantage to man, making the grain much harder to gather. One of the most striking results of the domestication of wheat, therefore, has been a reduction in this character, until the present varieties are reached, in which the head remains compact until it is threshed. (Fig. 2.)

transition form from primitive to higher construction—a combination of the spade-plow and the wedge-plow.

Another form going back in principle to the spade-plow is the so-called "zoche," the ditch-fork or mattock-plow. It is used principally in Slav districts—Prussia, Littauen, Letten—but was used much farther west at an earlier date, for the Lüneberg farmers of Wendland yet say "zochen" for "pflugen," to plow.

All of these plows have a beam which does not permit the depth of the furrow to be regulated; they must be dragged by the plowman, which involves very hard labor. At a very early age man endeavored to evolve a form that would lighten his labor, and produced:

2. The wedge or sole-plow. This allowed the depth of the furrow to be regulated, and lightened the labor. The principle is to change the position of the shoe instead of the handle, as was required in the ealier form.

By the addition of a mold-board this plow developed into a garden plow, with which in prehistoric times Germans or Celts cultivated the so-called High Fields (Upper Bavaria, Jütland). Its development can be followed in every country among all the Indo-Germanic peoples, and the type is today in use everywhere.

THE PLOW IN GREECE.

From Greece we possess a picture of the goddess Kora (Persephone), with an ancient model of this type of plow. It was formerly considered that the distribution of this plow was from Greece, with the spread of Hellenic culture. Such is not the case, for we find this type of plow among all Indo-Germanic peoples, even in places where Grecian influence can not even be suspected to have reached. In its most primitive form, it has been found fossilized in West Prussia, near Papau.

At a very early period a wheel-frame was constructed, mold-boards added, and small improvements made, with which the plow became one of the household utensils of the Indo-Germans and accompanied them on their wanderings. We find this type among the Iranians and Hindus, in the Caucasus among th Georgians and Ossetes, still in its most primitive form. The Slavs have changed it only in small details, not to advantage, and of its original Indo-German origin there can be no doubt.

As a result of his deep researches, Braungart [4] comes to the conclusion that the original home of primitive Indo-German agriculture in the broadest sense of the word, is to be sought in the present-day German empire and surrounding territory, and only to an unimportant extent in southern Scandinavia. Further, that the agricultural implements were, in principle at least, well developed as early as the late Stone Age, and that the separation of the peoples at the beginning of their migrations is to be placed at the middle, if not in the earlier part, of this neolithic age. The old Indo-Germans therefore possessed, at least 10,000 years ago, a well-developed art of agriculture, were a settled population, and had a considerable civilization.

Finally, a few words on my special subject, animal husbandry.

The most important domestic animals—dogs, pigs, cattle, sheep, goats—confront us, sometimes represented by numerous types, in the new Stone Age. The horse seems not to have been tamed until later; likewise poultry.

THE DOG PREHISTORIC.

The dog, it is generally admitted, comes into our field of knowledge at the same time as man himself. And before proceeding I want to remark that we agriculturists must take with caution the very suggestive but very fanciful picture of Ed. Hahn, of early man domesticating animals from religious motives. Hahn believes that man subdued and bred wild animals in order that he might always have at hand subjects for offering to the gods. Whoever

[4] Braungart, R. Die Urheimat der Landwirthschaft aller indogermanischen Völker an der Geschichte der Kulturpflanzen und Ackerbaugeräte in Mittel-und Nordeuropa nachgewiesen. Heidelberg, 1912, C. Winter.

PREHISTORIC AGRICULTURE

Resident of the Bronze Age plowing with a yoke of oxen. This engraving was made with flint on the carefully smoothed wall of a cave near Bohuslän in southern Sweden. It dates back probably several thousand years B.C., and possibly much earlier, according to Braungart, from whom the cut is taken. The simplest possible form of plow not operated by man alone is here shown; it is still found, almost unchanged, among modern Iranians in northern India. (Fig. 3.)

knows the sober mind of the Germanic peoples must reject this hypothesis absolutely and agree that utilitarian motives alone acted. Instead of following wild animals with the hounds all his life, man found it more convenient to pen up the wild animals and feed them. Further progress in breeding came by its own momentum.

Among dogs we find today a host of varieties and types. That is partly due to the diversity of the wild material—wolves and jackals—which originated them, in part to the extraordinary variability of the species. Apparently the dog is a product of the old Stone Age.

Cattle were probably—in part, certainly—domesticated in the first part of the new Stone Age. The wild stock was the Ur or Aurochs in various forms. I have made a particular study of the ancestry of cattle and especially of the black and white race.[5] The literature designates it as *Bos taurus germanicus*, as distinguished from the red breed, *B. taurus celticus*. The first is considered to be a product of Germanic breeders, the latter of Celts. But when one collects all the data regarding the earliest known distribution of these types, and compares it with the known history of the peoples, one arrives at quite an opposite conclusion. For the black and white cattle are beyond all doubt a heritage from the Celts, who in those days lived to the east of the Germanic peoples, in the present empire of Russia, while the Germans had red cattle with light muzzles and sometimes white spots. These two varieties of cattle were distinct in origin and have no connection with each other. From the fact, however, that these two neighboring peoples had different kinds of cattle, we must conclude that the domesticating of cattle went on independently in a number of separated districts, at a date subsequent to the separation of Celts from Germans and after the art of agriculture was tolerably wel known. It was not until much later that the Celtic tribes, wandering westward, took their black and white cattle with them, and from the distribution of these cattle during historic

[5] Represented in the United States principally by Holstein-Friesian cattle.

ANCESTOR OF DOMESTIC GOATS

The Pasang or so-called Grecian Ibex (*Capra hirtus*, var. *aegagrus*). Although Dr. Dettweiler seems not wholly to accept the theory, most zoologists are firmly convinced that the Pasang is the ancestor of the domesticated goat of the present day (*Capra hirtus typica*). In the time of Homer it was common in Greece, but now is confined principally to Asia Minor, Persia, and Afghanistan. R. Lydekker says the Swiss domesticated goat is "certainly its descendant" and that it probably is the foundation of all other modern breeds, although local crossings with other wild species may have aided in producing the diverse modern races. It is a slender animal, three feet high at the shoulder, and ranges far up in the mountains, usually avoiding the lowlands altogether. Photograph by E. R. Sanborn, New York Zoological Society. (Fig. 4.)

times we have some ground for drawing conclusions as to where the Celts settled on various occasions. We can follow them through Germany and Jütland, southern Sweden and Norway, into France, Great Britain, Spain and finally Asia Minor.

SWINE EARLY TAMED.

Swine seem to be an older acquisition of the race, since Celts and Germans possessed the same breed, a huge hog with pendulous ears. No wild form of this type is now in existence—it has died out along with the wild ox, the ur, or aurochs, which furnished the material that made up domestic cattle. The short-eared swine of eastern Germany did not arrive until the invasion of the Slavs.

We can distinguish various breed of sheep, without being in a position today to say whence they came. The Neolithic people had serveral types.

As for goats, researches still in progress show that we have two very different forms, neither of which is of known ancestry. Augst has proved that there is a German goat, with curved horns, and a Celtic form with larger,

sweeping horns. The latter type long ago began to preponderate and seems likely in a short time to dispossess the Germanic type altogether.

With horses we are also in a position at present to distinguish several original stocks. The Celts deserve credit for taming the oriental horse, the so-called warm-blooded one; and perhaps this fact gives us a clue to place the Scythians and other nomads of the Russian steppes in their proper place, ethnologically. We may assume that the Celts took this horse with them on their wanderings, on the one hand eastward—Iranians, Persians, Medes, Cimmerians, etc.—and on the other hand westward. The oriental type of horse was well-known for the late neolithic period, and the Bronze Age, through excavations in many parts of Germany and France, even to England, and furnished support to the hypothesis of immigration from Asia. Today we know that it is a genuine old Indo-Germanic product, which never had anything to do with Asia, still less with the Arabs. For the latter got it only in a relatively very recent period, probably about the beginning of the Christian era. Herodotus states expressly that the Arabs in the army of Xerxes had only camels, that they were the only people without horses, and Strabo notes the lack of horses in Arabia. Probably the horse was introduced to Arabia from Egypt. The Egyptians, however, are supposed to have received it (1800 B.C.?) from Libya to the westward; and here we enter upon hotly contested ground.

THE NORTH AFRICAN BLONDES.

In North Africa one frequently finds remains of the blonde, northern European race, which obviously was there far prior to the invasion of the Vandals; there is much reason to believe that in a remote time Northern Europeans must have entered Africa through Spain The dolmens and other finds add evidence. When one collects all the scattered data regarding the horse, it seems not at all impossible—however fantastic such an idea may at first sight appear—that in the prehistoric time, perhaps about the time when the Hellenes and Italians were wandering, Celts entered Spain and crossed over into Africa, where their posterity, the Berbers, still work for the French and Italians. Through these, then, the horse would have been carried along the Mediterranean to Egypt and Arabia, whence it was brought back centuries later, to be paired in England with its much changed relative, the Celtic Pony, and produce the modern running horse, the so-called thoroughbred.

The Germans themselves had a heavy, clumsy horse that was more useful for draft than for riding purposes. From this, during centuries of breeding, selection, and improved environment, the great cold-blooded breeds, the cart-horses, were produced. They are a product of the forests, whereas the thoroughbred is a product of the steppes.

If one asks why our forefathers at a much earlier day had not tamed horses, along with cattle, one must remember that even a few thousand years ago the horse was much smaller than he is today, similar to our ponies. It was too light to ride, and in the yoke the oxen surpassed it. There was, therefore, no great advantage to be gained in domesticating it, since its flesh hardly justified breeding operations, the meat of swine, sheep and goats being obtainable more cheaply and conveniently.

As a people, the Celts have become insignificant, but their horses, their cattle and more recently their goats have gained an important, even dominating, part in the animal industry of Europe.

Permanent Reform

Until the movement of heredity is changed, physical and moral deterioration will move side by side in ever-expanding streams. In the long run no reform can pervail which does not look toward the creation of a sober, clean and law-abiding stock.—Rev. Amory H. Bradford: Heredity and Christian Problems (1895).

COAT COLOR IN HORSES

Tabulation of Color of 42,165 Horses Allows Definite Conclusions to Be Drawn as to Value of Different Factors—Errors in Registry and in Genetic Description of Colors—Connection Between Gray and Roan.[1]

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HURST, Wilson, Harper, Sturtevant, Anderson and others have published papers on the Inheritance of Coat Colors in Horses. It is the purpose of the writer to give a summary of all the available figures on the subject and his interpretation of them. The sources of the figures collected are the various Stud Books. As a matter of fact these can not be accurate. I, myself, have used the American Saddle Horse Register. This Register has been compiled within two or three decades and has been revised within a decade. I find errors in it approximating two percent. for color and as great a percent. of errors that might be considered of a typographical nature. There is no reason to believe that other registers are more nearly accurate than the Saddle Horse Register.

As will be noticed from the following table of figures the matings have been grouped under the registered colors as: chestnut x chestnut, chestnut x black, chestnut x brown, etc. That is, when both sire and dam are chestnut it is designated a chestnut x chestnut mating. When one is chestnut and the other is black it is tabulated as chestnut x black and so on. No attempt has been made to keep the records for sexes, for the reason that color is transmitted regardless of sex. The result from mating a bay stallion to a chestnut mare is the same in the color of the foal as if the cross had been reciprocal, a chestnut stallion mated to a bay mare.

The stud books recognize the following colors in horses: gray, roan, dun, bay, brown, black and chestnut. As a rule the variations of each of these colors are not recorded in the stud books.

The gray coat is made up of white and black hairs and varies from the almost white to the almost black, and includes a large class of horses whose coat is of the dappled pattern. When young, the gray horse exhibits this dappled condition or is what is designated iron gray, but as age comes on the dapples disappear and white and black hairs are to be found. Later on the black may almost be lost and result in a white horse. This white, however, does not seem to be of the same nature as the white found on spotted ponies and some classes of horses. This latter is a snow white with white skin underneath, while the white found on the old horse is due to the partial disappearance of the black hairs.

The roan pattern assumes three forms. One of these is the red-roan in which the coat is composed of bay and white hairs. The second is the blue-roan which constitutes a coat of black and white hairs. The other form of the roan pattern is the chestnut roan. The coat in this case is due to white and chestnut hairs.

DUN COLOR RARE.

The dun or cream colored coat is not found in any great numbers. It varies in shade from the dark to the light cream. Once in a while the mane and tail have the same cream color as the body coat, but the most usual condition is dun body and black mane and tail with black on feet and legs.

[1] The material here presented has been published in Bulletin No. 180 of the station, July, 1914.

BREEDING OUT THE GRAY

This gray mare is out of a gray dam, but has solid colors in her sire's ancestry. Her foal is bay by a bay stallion. Gray is ordinarily dominant to bay (and to other colors) and the fact that it does not appear in this colt shows that he has lost it permanently and that he can not transmit it to his own progeny. (Fig. 5.)

The fashionable color for almost all classes of horses is the bay.[2] The average bay horse has bay hairs on the body, but black on the legs, mane and tail. This black may extend along the back and up the legs to the body and even appear on the underline of the barrel. When the sides of the body show black in alternating patches with bay, the horse is frequently registered as a brown. This brown is known among horsemen as a mahogany brown. As common practice allows mahogany browns to be registered brown it makes it quite difficult to interpret some results as shown by matings. The mahogany brown is a bay. The coat is a compromise between bay and black but it is not blending although it resembles a blend. In technical terms it is a simplex bay, that is, a bay produced by two germ cells one of which carries the *determiner* for bay, the other carrying the *determiner* for black, the bay *factor* in this union not showing the usual dominant strength which should exclude black hairs from the body. The mahogany bay represents the one extreme of bay and varies from this condition to the bay that has no black hairs on body or legs. The bay hair varies in shade from the very dark wine colored bay to the very light shade close to chestnut.

In all the stud books examined the horses registered as brown may vary in shade from the dark or mahogany bay to black. As noted above the so-called mahogany brown is a dark bay and should be so registered, although custom sanctions the other method. The horse which is called seal brown by horsemen is almost a black horse. The top line is all black, as is the mane and tail. The legs, except for possible white markings, are black up to the body. The body is very dark, in some cases showing a lighter shade near the flanks and back of the nostrils. The flanks and muzzle are said to be tan in color.

The lighter shade, called tan, on muzzle, flanks and sometimes the hips is not due to the presence of brown hairs for the reason that there are no

[2] Comparison of early and late volumes of the Register shows that the American Saddle Horse is going rapidly to a chestnut color. This is partly due, doubtless, to the ease with which chestnuts can be bred, all that is necessary being to mate a chestnut sire and chestnut dam.

true brown horse hairs unless some shades of bay or chestnut be so called. The tan shade is due to an alternation of black and bay hairs, the bay hairs being very dark and in many cases only showing bay on the outward ends. The horse designated as seal brown is a black in which not all the bay has disappeared. There is just enough of the bay tendency left to produce lighter shades in places on the body.

Black varies in shade from the so-called seal brown to the jet black. Most black horses when exposed to the sun for some weeks show a faded condition. The ends of the hair show a bay tinge.

The chestnut coats present a variety of shades from the dark liver color to the light sorrel. The mane and tail follow closely the body shades in variety, the lighter chestnuts often showing the crushed strawberry or flaxen shade in the hair of the mane and tail. There is the presence of enough of white hairs among the chestnut ones to give it the light effect.

MANY MATINGS STUDIED.

In going through the American Saddle Horse Register I secured the color in 5,591 matings, which involve the color of 16,773 horses. To these numbers I am able to add from Sturtevant's tables 8,464 matings, giving a total of 14,055 matings or the color of 42,165 horses. This number is sufficiently large, it seems to me, to enable proper deductions to be drawn, unless it is in the case of the rare colors.

The tables herein given make no distinction in the shades enumerated for the reason that the registration books do not give them. The percentages are figured in round numbers so as to exclude all fractions.

The tabulated matings and the resultant foals are:

Breed	*Chestnut*	*Black*	*Brown*	*Bay*	*Authority*
CHESTNUT X CHESTNUT.					
Thoroughbred	1095	9	(bay or brown)		Hurst
Shire	44	1	1	5	Wilson
Trotter	69	0	0	0	Sturtevant
Saddle	410	0	0	0	Anderson
Total	1618	16 not chestnut			
	99%	1%			
CHESTNUT X CHESTNUT.					
Suffolk	12497	0	0	0	Anderson
CHESTNUT X BLACK.					
Saddle	111	83	20	124	Anderson
	33%	24%	6%	37%	
CHESTNUT X BROWN.					
Saddle	60	32	31	130	Anderson
	24%	12%	12%	52%	
CHESTNUT X BAY					
Saddle	597	56	49	764	Anderson
	41%	4%	3%	52%	
BLACK X BLACK.					
Percheron	0	49	2	not black	Harper
Shire	2	39	0	3	Wilson
Clydesdale	0	36	2	0	Wilson
Trotter	2	34	4	2	Sturtevant
Saddle	7	137	7	0	Anderson
Total	11	295	15	5	
	3%	90%	5%	2%	

Breed	*Chestnut*	*Black*	*Brown*	*Bay*	*Authority*
BLACK X BROWN.					
Thoroughbred	0	8	20	12	Wilson
Shire	4	39	36	19	Wilson
Clydesdale	1	61	106	34	Wilson
Trotter	1	11	9	5	Sturtevant
Saddle	8	79	48	45	Anderson
Total	14	198	219	115	
	3%	36%	40%	21%	

BLACK X BAY.

Thoroughbred	14	1	27	33	Wilson
Shire	19	39	43	125	Wilson
Clydesdale	7	40	67	104	Wilson
Trotter	7	16	31	48	Sturtevant
Saddle	76	199	93	324	Anderson
Total	123	295	261	634	
	10%	22%	20%	48%	

BROWN X BROWN

Thoroughbred	11	6	114	78	Wilson
Shire	2	7	27	20	Wilson
Clydesdale	0	32	165	34	Wilson
Trotter	0	5	7	7	Sturtevant
Saddle	0	14	21	18	Anderson
Total	13	64	334	157	
	2%	11%	59%	28%	

BAY X BROWN.

Thoroughbred	123	10	365	741	Wilson
Shire	5	23	56	133	Wilson
Clydesdale	5	25	254	206	Wilson
Trotter	8	9	31	81	Sturtevant
Saddle	36	65	111	285	Anderson
Total	177	132	817	1449	
	7%	5%	32%	56%	

BAY X BAY.

Thoroughbred	270	1	125	1295	Wilson
Shire	28	13	18	287	Wilson
Clydesdale	5	6	59	243	Wilson
Trotter	9	1	3	46	Sturtevant
Saddle	162	86	95	960	Anderson
Total	474	107	300	2831	
	13%	3%	8%	76%	

	Chestnut	*Black*	*Brown*	*Bay*	*Gray*	*Roan*
ROAN X CHESTNUT.	9	3	2	9	1	14
ROAN X BLACK	1	11	3	1	0	15
ROAN X BROWN.	1	5	16	18	1	28
ROAN X BAY.	9	5	13	39	1	50
ROAN X GRAY	0	0	3	0	5	7
ROAN X ROAN.	0	0	0	3	2	9

GRAY X NOT-GRAY

	Gray	*Not-Gray*	
Thoroughbred	73	56	Wilson
Shire	146	186	Wilson
Clydesdale	9	15	Wilson
Trotter	141	142	Sturtevant
Saddle	70	129	Anderson
Total	439	528	
	46%	54%	

GRAY X GRAY.

All Breeds	47	18
	72%	28%

The writer found while tabulating the matings for color in the Saddle Horse Register that some foals were reported not chestnut from chestnut matings. I was able to find the owners or breeders of these foals. In every case I found that a mistake had been made in the record. I was able to report 410 chestnut x chestnut matings which all resulted in chestnut foals. Later I secured Hurst's figures, 1905 chestnut x chestnut matings with a reported nine not chestnut. Hurst used the Thoroughbred Register of England and must have gone back in the earliest numbers. There is no doubt in my mind, as Hurst himself intimates, that the nine are mistakes in registration. In all breeds there are 1618 chestnut x chestnut matings producing all chestnut except 16 according to the records.

SUFFOLKS ALL CHESTNUT.

Recently, I have secured from Fred Smith, Secretary of the England Suffolk Horse Society, a statement to the effect that this Society has registered 12497 horses, all chestnuts from chestnut matings. The breed traces back to a chestnut horse as the founder in 1769. One of the requirements is that a Suffolk shall be chestnut.

I have been contending for three years that chestnut is a true recessive. I have asked in the stock papers for an example of a foal that is black, bay or gray from parents both of which are chestnut. No breeder has volunteered the information because he has not had that experience in his stud. The twelve thousand matings and over from the Suffolk Horse Society substantiate my position.

Other evidence of its recessive nature is necessary than that chestnut matings produce only chestnut foals. Any color can behave that way in reproducing itself if it be pure bred. The matings of the Suffolk Horse all come from chestnut ancestry and alone would not be conclusive proof that chestnut is a recessive. The chestnut matings which I have tabulated present individuals with all colors in their ancestry. There would be a tendancy to transmit these various colors if it be not recessive.

Another conclusive proof of its recessive nature is its production from other colors. The above tables show that in black x black matings there are 3% chestnut foals, black x brown give 3% chestnut foals, black x bay give 10% chestnut foals, brown x brown give 2% chestnut foals, brown x bay give 7% chestnut foals, bay x bay give 13% chestnut foals. Here are six classes of matings with no external evidence of chestnut in the animals mated, yet regularly there come from them chestnut foals. If chestnut is recessive this is what we should expect and we should expect the chestnuts to breed true to their color when thus produced. The chestnut horses do breed true for chestnut no matter what the color of their ancestry has been.

A striking example of the recessive nature of chestnut is to be found in The Theorist, a trotting bred stallion. The three generations before him are of solid colors other than chestnut. The fourth generation has one chestnut individual, and the fifth two. He is chestnut with flaxen mane and tail.

SOME CHESTNUT MATINGS.

The other writers on the subject have not given any figures showing the behavior of chestnut when mated to bay, brown and black. I find that black x chestnut matings give 33% chestnut, 24% black, 6% brown, and 37% bay. Brown x chestnut matings give 24% chestnut, 12% black, 12% brown, and 52% bay. Bay x chestnut matings give 41% chestnut, 4% black, 3% brown and 52% bay. The brown x chestnut matings give 52% bay. This is not unexpected when we remember that most of the horses registered brown are genetically bays and should have been so registered.

A real difficulty is encountered with the black x chestnut matings, for here we find 6% brown and 37% bay. Both black and chestnut are recessive to bay and there should be no bay foals from this class of matings. There is evidently some relationship between the factors which produce chestnut and black and the factors which produce bay. Just what this relationship is I am unable to say.

There are some stallions that are homozygous for their own colors and are unable to produce even from chestnut mares any chestnut foals. The two bay trotting stallions, Bingen and Alcyo, we have found, do not produce any chestnuts, although each one has had numerous mares who to other stallions do produce chestnut foals.

Black is dominant to chestnut and hypostatic to brown, bay, gray and roan. The percentages are from a total of 326 black x black matings: 90% black, 3% chestnut, 5% brown, 2% bay. The brown and bay from black matings are very small, not enough to vitiate the conclusion that black is hypostatic to these two colors as well as to gray and roan. Under the present methods of registration there can be no sharp line of demarcation between bay, black and brown. I am confident that as the records are now made up enough errors have crept in, by registering bay or brown, to account for the exceptions above mentioned. In the opinion of the writer, from true black horses mated to true black, only black and chestnut foals will be obtained. The percentage of black colts from the cross of black and brown and black and bay are 36% and 22% respectively; just about the figures that the Mendelian law would require.

In the tabulation given above the stud book records are taken for brown. As indicated elsewhere in this bulletin mahogany bays are usually registered as brown. All mahogany bays are genetically bay and should be registered as bay.

The seal brown which characterizes the larger number of horses registered as brown is just a light shade of black horse and should be so registered. To make all stud books conform to a uniform standard the so-called brown should be eliminated. The mahogany browns should all be classed with bays. The seal browns should be classed with blacks. Should this be done the black horse would have its variations in shade as do the other recognized colors.

In view of all the evidence the series seems to be: chestnut recessive to all, black dominant to chestnut and recessive to all others, bay dominant to chestnut and black and recessive to the three coordinate colors, gray, roan and dun.

The colors can be arranged in three series:

Gray	Roan	Dun
Bay	Bay	Bay
Black	Black	Black
Chestnut	Chestnut	Chestnut

The color at the top of the series is dominant to all members of the series. Chestnut comes last and is recessive to all above. There is no question that bay is recessive to gray, roan and dun, and dominant to chestnut and black.

WHEN BAY IS DOMINANT.

Our records show 3712 bay matings, and there is not a single gray, roan, or dun horse thus produced. This is convincing evidence that bay is hypostatic to the three colors which head the various series.

The evidence of the dominant nature of bay to black and chestnut is that out of the 3712 bay matings 76% are bay, 3% black, 13% chestnut and 8% the so-called brown.

That gray and roan are dominant to bay there can be no doubt. Nine hundred and sixty-seven foals from matings gray x not-gray produced 46% gray and 54% not-gray. It is known that homozygous gray when mated with any of the four popular colors will always produce a gray. It is only from a heterozygous gray that other than a gray can be produced. We have no records that would indicate the comparative strength of dun, roan and gray. For the present we place them at the top of the series as of coordinate strength.

The factor for the roan pattern seems to be independent of the factor for color. There are the three factors, or three causes, for the colors, chestnut, black and bay. Intimately mingle white hairs with chestnut and the result is a chestnut roan. White hairs with the black coat in sufficient numbers give the blue or black roan. The bay, or strawberry, roan is due to a mingling of white with the bay coat-color. The factor, or cause, for the roan condition

appears to work independent of the determiners for the colors.

There is a reason in the behavior of color factors, in transmission, why a coming foal shall be a bay. Acting in the same germ cells for this foal is the factor for the roan condition and the combined result of the two factors is to produce a bay roan. Should the factors for color have been black or chestnut instead of bay the roan factor would have acted in the same manner except the result on the foal would have been a black roan or a chestnut roan, according to the resultant of the factors for those colors.

The determiner for roan is present or not present in the germ plasm. If present it will be seen in the coat of the mature horse. Its presence is dominant over its absence. It in no way interferes with the inheritance of the colors among themselves

Like the gray, roan cannot always be detected in young foals. They appear to be bay or black at first, and some show this condition until they shed, when the roan becomes visible.

When once in the germ plasm of a strain of horses its persistence is remarkable. The famous trotting sire Jay Bird got his roan from his grandmother, Lady Franklin, about whose ancestry we know nothing. A large percent. of the get of Jay Bird were roan and it lingers in his descendants to some extent even to the present. But when it disappears it is like the gray, it will not reappear. To get it again it is necessary to go back to it.

A good illustration came to our attention recently. An intelligent horse breeder bred the progeny of a famous gray horse for five or six generations. He lost the gray at the beginning, but did his breeding expecting it to reappear with each new generation. He of course met with disappointment.[3]

So alike is the behavior of gray and roan that the evidence points to a unity of the two. The gray horse is, perhaps, one form of the black roan. When the pattern is in the dappled form which with the black disappears with age, we call it gray. The difference between the gray and black roan is only one of pattern and the quantity of white hairs. The white is much more plentiful in the gray than in the roan. It is a question of quantity, I believe, and not of kind which distinguishes the roan from the gray. I am confident that further research will show a close relationship of the factors for gray and roan.

There is evidence that dun is dominant to the solid colors, but there is no evidence of the comparative strength of gray, roan and dun.

[3] By eliminating at each generation the few chestnuts produced, a breeder can easily secure a family of horses that will produce nothing but blacks. To produce a family of bays requires more time and patience, since the external appearance of a bay tells us little of his genetic qualities. Grays are becoming scarce and of very mixed ancestry—to produce a family of horses that bred pure gray would now be a difficult task for any except the Percheron breeder.

BIBLIOGRAPHY.

HURST, C. C.—On the Inheritance of Coat Color In Horses. Proceedings Royal Society 77 B, 1906.

STURTEVANT, A. H.—A Critical Examination of Recent Studies on Color Inheritance in Horses. Journal of Genetics, February, 1912.

HARPER, E. H.—Biological Bulletin, October, 1913.

WILSON, JAMES.—Scientific Proceedings of the Royal Dublin Society, No. 28, 1910.

WENTWORTH, E. N.—Color Inheritance in the Horse. Sonderabdruck aus der Zeitschrift für induktive Abstammungs und Vererbungslehre, 1913, Bd. 11, Heft 1 u. 2. Verlag von Gebrüder Borntraeger in Berlin W. 35.

ANDERSON, W. S.—The Inheritance of Coat Color in Horses. American Naturalist, October, 1913.

ALBINISM IN MAN

Extensive Researches of Galton Laboratory Lead to Denial of Its Mendelian Behavior—Warning as to Enunciation of Rules Governing Marriage—Eugenists Must Seek More Knowledge Before Offering Advice.

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HAPPILY contrary to expectation, the six volumes [1] already issued from the mathematical atmosphere of the Galton Laboratory (London) on the subject of albinism present no such arid acreage of numbers as one is usually invited to contemplate by investigators at that institution. With Adam and Eve (who have been assumed *a priori* by Christian mankind to have been white) as a starting point, the authors have traced the history and geographical distribution of albinism with all the charm and freshness of a traveller's tale, while a passion for micrometric accuracy and critical sifting of authorities have rendered the reading of the whole first volume a scientific delight. The second volume of text is devoted to the treatment of isolated cross sections of the problem of albinism, such as the microscopic structure of the albinotic eye in man and animals, the structure and composition of albinotic hair, seasonal variations in granular pigment content in the coats of birds and animals, and the many side-lines that such a study naturally involves. Two photographic atlases and one volume containing over 650 pedigrees of human albinism and partial albinism attest the remarkable co-operation that it has been the well-deserved good fortune of the investigators to secure. Detailed descriptions of the pedigree material, whose collection and working up has covered already a period of eight years, fill the text of Part IV, save for the space given to a bibliography of 700 titles of works on albinism, the cream of which has been incorporated in the present monograph.

A bare list of the interesting facts concerning albinism in history, geography, medicine, folk-lore and anthropology would more than fill the space allotted for this brief review, so that only a few of the high-lights can here receive mention.

VARIETIES OF ALBINISM.

A complete albino, for the purposes of this investigation, is described as an individual whose skin is of a characteristic pallor or milky whiteness, whose hair is white tinged possibly with yellow or straw, and whose eyes have pink or red pupils, translucent irides with the usual accompaniments of defective vision, nystagmus and ametropia. Incomplete albinism embraces all conditions where the aforementioned factors are not all present. Albinism as thus defined occurs practically in every section of the world and in almost every variety of the human race, manifesting itself in the black races of Africa, the brown races of the Americas, the yellow races of Asia and the whites of Europe and America, both in its complete and incomplete form. The range of variation, from a dash of whiteness on the skin or the dilution of pigmentation in an eye to complete albinism, is held by the authors to preclude the possibility of treating this condition as a unit character in heredity and to indicate that before it can, even with the greatest latitude, be so treated, a vast

[1] Drapers' Company Research Memoirs, Biometric Series. A Monograph on Albinism in Man, by Karl Pearson, E. Nettleship and C. H. Usher. Vols. I–VI. London, Dulau and Co., Ltd.

amount of further work must be done along the lines already worked in part.

Pigmentation in albinos, especially that of the eye, seems to increase with age. Nystagmus is almost always present in albinos and a high degree of hypermetropia and astigmatism are found in higher correlation with albinism than with normality, but the poor sight charactersitic of individuals affected with albinism is due more to deficiency of retinal pigment than to these defects. Hair color is due to pigment diffused through the fibrilae of the hair like a dye, or as distinct granules of pigment bewteen the fibrilae. This duality, because the authors consider the absence of granular pigment the distinguishing mark of albinism in hair, is presumed to preclude the study of the heredity of pigmentation without the aid of the microscope. Further, there is the suggestion of changes in pigmentation, such as those that accompany age and those that seasonal changes occasion, which the authors think must be taken into account for thoroughness' sake. Experiments on Pekinese spaniels, conducted by the investigators, led to the drawing of conclusions similar to those derived from the study of albinism in man with special emphasis on the fact that, although tested according to Mendelian formulas, "no simple form of Mendelian theory applies to the coat color of dogs."

Although the spirit of fairmindedness runs through the whole monograph, yet one cannot help noticing a distinct refrain of antimendelism which crops out again and again with such emphasis that it must be mentioned here not through any desire to enter this field of controversy but because it nucleates so much of the material dealt with and seems to play so large a rôle in the thought of the authors that it may not well be omitted. As this memoir comes from a laboratory of Eugenics, one is led to conclude that its principal object is related to this young science and that whatever social connotations it may carry are more important than its bearing on or relation to ophthalmology or geography. The following quotation, therefore, would seem to embody the essential spirit of the whole and may fittingly be cited as indicative of the main conclusions of the work already done.

Say the authors:

"As we have seen in the course of this work albinism is a graded character, and we have every reason to believe that both in man and dogs separate grades are hereditary. Further than this we should hesitate to go at the present stage of our experimental work.

MENDELISM AND EUGENICS.

"Mendelism is at present the mode —no other conception of heredity can even obtain a hearing. Yet one of the present writers at least believes that a reaction must shortly set in, and that the views of Galton will again come by their own. At any rate as far as we have gone at present the experiments on dogs seem to indicate that there is still a chance for philosophic Darwinism—*i. e.*, the theory that small variations are continuously occurring and can be perpetuated by selection. The problem of whether philosophical Darwinism is to disappear before a theory which provides nothing but a shuffling of old unit characters varied by the appearance of an unexplained fit of mutation is not the only point at issue in breeding experiments. There is a still graver matter that we face, when we adduce evidence that all characters do not follow Mendelian rules. Mendelism is being applied wholly prematurely to anthropological and social problems in order to deduce rules as to disease and pathological states which have serious social bearing. A careful record of facts will last for ages, but theory is ever in the making or the unmaking. In all that relates to the evolution of man and to the problems of race-betterment, it is better to admit our present limitations than to force our data into Mendelian theory and on the basis of such rules propound sweeping racial theories and inculcate defiite rules for social conduct. Even if the offspring of an albino parent be themselves normal, we cannot advise them that all is safe if they marry into normal stock; for not only is Mendelism

not yet demonstrated for human albinism, but who shall determine what is 'normal' stock, when over and over again the albino appears in the mating of two stocks which have no record of previous albinism? Let us rather adopt the tone of the sooth-sayer in Antony and Cleopatra and when we are asked 'Is't you, Sir, that know things?' reply modestly, 'In Nature's infinite book of secrecy a *little* can we read.' We await the gradual building up of more complete knowledge."

In perusing this truly admirable piece of hard and conscientious work, despite the manifest desire of the authors to square the facts gathered with the underlying principles that may be found to govern the appearance of the facts, there comes irresistibly to mind Mrs. John Martin's likening of scientists to sick widow's children who keep gathering nuts which nobody at home can crack and pointing to the nuts as wealth. The authors of this monograph have gathered an invaluable store of interesting facts and their desire is to relate these facts to the problem of heredity, but whether we must wait until the microscope has told us all it knows of human hair, and eye, and skin before we may conclude, from the symboled pedigrees that are coming to hand in greater and greater numbers, that albinism behaves recessively or no, is an open question. With the greatest respect for the scientific labors of our three authors and their generous collaborators in the field of detail and correlation, it would still appear that, in so far as the strictly hereditary and social aspects of albinism are concerned, this monumental work is indeed, as the authors have been the first to see it, but a small beginning and initial stimulus for further research.

Heredity and Environment

The correctness of statistical measurements of the relative force of heredity and environment is vigorously defended by Karl Pearson in Biometrika (X, 1, April, 1914), in answer to recent writers in the *Eugenics Review* who have declared such measures to be fallacious. Pearson replies that his critics question the accuracy of the statistical method because they do not really understand what a coefficient of correlation is, nor what mutiple correlation means. His own well-known position is that heredity is at least five or ten times as important as environment, in the individual; he proceeds to show that this is really a conservative estimate, and that even in the most extreme case supposable, the influence of heredity would still be preponderant. He assumes that there is an *infinity* of environmental factors which have the same correlation as a parent with the child, and that there is assortative mating of the child's parents; even in such a case it is only necessary to take the grandparents into account to show that "together grandparents and parents would influence a man's character more than an infinity of environmental factors of the same grade of correlation, because the latter factors are far more highly correlated together than several of our relatives."

Eugenic Progress

A period seems to come in the religious development of nearly every civilized community when the moral conscience is awakened to its responsibility for the weaker and less competent stocks, who, inheritors of the racial faults and failings, are true scapegoats by which the progress of the race is assured to others. If, however, the effect of this altruistic movement in directing the attention of society to the condition of the unsuccessful and unhealthy be to discourage and hamper the families of the able and robust, no further racial progress is possible, and degeneration will set in.—W. C. D. and C. D. Whetham: Heredity and Society.

THE LAWS OF NAUDIN-MENDEL

An Interpretation of the Statistics of Pearson, Nettleship and Usher, on Albinism in Man—Practical Rules to Regulate Marriage of Members of Tainted Family Stocks.[1]

DR. E. APERT
Physician of the Hospitals of Paris, France.

I BEG your pardon, gentlemen, for returning to this subject of the application of the laws of Naudin-Mendel to the human species. I have previously discussed the question in my book *Maladies Familiales;* I have treated it in various magazine articles; I expounded it again at the International Eugenics Congress in London. I would not come back to it this time if it did not seem to me absolutely necessary to do so. These laws are the very foundation of studies on heredity; they constitute the clue which at last saves us from losing ourselves in a chaos of facts that at first sight are multiple, deceptive and contradictory; thanks to them, we may dream of establishing a rational science of eugenics; if they do not correspond to the facts, we have no basis on which to pursue our eugenic studies.

We must be very certain, then, of the legitimacy of their application to the human species. This legitimacy has very recently been once more called in question. Happily new data permit me to establish the laws this time, not by analogy, by generalization for man from observations on lower animals, but by direct demonstration.

Let me recall that as a result of the observations of Naudin and Mendel on crosses between varieties of the same species of plant, and as a result of more recent confirmatory studies, we thought we could consider the conclusions of their studies as definitely established. These conclusions were the *segregation of forms in the posterity of crosses* (Naudin), and the existence of *definite mathematical proportions between the numbers of descendants belonging to each of the segregated forms* (Mendel). As these laws had been verified in very diverse species of plants and animals, and for very diverse morphological, physiological and even pathological characters,[2] their extension to the human species might have been thought indisputable and undisputed, and their application to the field of eugenics, which I have tried to make, might have been thought wholly legitimate.

ATTACKS ON THE LAWS.

But the legitimacy of the application of the Naudin-Mendel Laws to the human species has not only been called in question, but violently disputed. An article by Dr. Guyenot, "Mendelism and Heredity in Man," published in his excellent journal *Biologica* (Jan., 1914), brings together a long list of objections of the most diverse application. These critics, it must be said, either limit themselves to the abuses which may occur in the premature application to particular cases, of principles which remain none the less unshakeable, or else waste their energy on the category of cases which I emphasized at London. In some cases the law of Mendel seems to fail, because various other factors add their influence to the hereditary factors governed by that law: such, for example, is the sexual factor (matriarchal heredity). To settle such cases, one method alone is practicable—

[1] Delivered before the Société Francaise d'Eugénique, May 6, 1914; translated from Eugénique (organ of the society), II, 5, 129ff., Mai, 1914.
[2] Hereditary ataxy in mice, rust resistance in wheat.

namely, the patient observation of numerous cases of inheritance in man.

Of course, the objection is at once raised that it is very difficult to observe the facts of heredity in man. The difficulties are indeed great, and there is every reason for insisting on them. The observation of facts of heredity can be much simplified in experimental plant and animal breeding, by judicious choice of the varieties with which one works, but no such expedient is available in the human species. It is very true, as critics have emphasized, that scientific prudence requires us, in dealing with heredity in man, sometimes to have a doubt about the real paternity of the subjects with whom we are dealing. It is very true that it is hard to push our researches farther back than two or three generations. It is very true that the ordinarily small number of descendants of any couple make the search for the Mendelian proportions deceptive. All of these difficulties are of the most inevitable sort. But because the verification of a law is difficult, shall we say that the law is untrue? Hardly! We are merely led to say that researches on a large scale are necessary to surmount the difficulties, and to verify or contradict the exactitude of the law. The work will be onerous, but may nevertheless be conclusive.

A good part of this work of collecting facts is now in process, thanks to the efforts of eugenic organizations. I do not refer to our own society, whose birth is too recent and whose funds too limited, to allow it to do such work; but you are familiar with the beautiful publications which make up the Treasury of Human Inheritance, issued by the Eugenics Laboratory of London, and also with the Drapers' Company Research Memoirs, published by the Biometric Laboratory of the University of London. In the latter series, Messrs. Pearson, Nettleship and Usher have just issued a big volume of pedigrees relating to albinism in man.

ALBINISM IN MAN.

Albinism is one of the variations which has been the most studied from the top to the bottom of the animal and vegetable scale, from the Mendelian point of view, and it has always shown itself to be recessive from that point of view. Here, then, is a good chance to see whether albinism obeys Mendel's Law in man, too; whether it is recessive, as it is with other living things. When it is realized that the work of these writers has brought together 691 genealogical trees, that many of them include three, four, five, or even six generations, that some of them include several hundred individuals, it will be admitted that the material on hand makes errors, if not negligible, at least much less important, so that their final influence on the results will be very slight.

In particular, the objection drawn from the small number of offspring of a single couple, in the human species, wholly disappears. If, instead of seeking the number of albinos among the offspring of a single couple, we seek the number among the children of some hundreds of couples, all of whom have given rise to one or more albinos, the result obtained will command some respect; and if it coincides with the Mendelian proportions, we have a right to assume that the law of Mendel is verified.

However, we do not obtain the large numbers necessary if we limit ourselves to investigating the direct descendants of albinos. For many reasons, albinos rarely marry; and their marriages are rarely fecund. Fertile marriages between two albinos are rare; in marriages between an albino and a normal the result is, according to the Mendelian law, variable according as the normal individual is homozygous (in that case there should be no albino offspring, according to the formula DDxRR = 100% DR), or as that individual is heterozygous (when we have DRx RR = 50% DR + 50% RR, or half of the children albinos). But in man, it is rare that we can say with certainty whether a subject of normal appearance is or is not homozygous. We can, therefore, get no help for our present study from statistics of children one of whose parents was albino and the other nor-

mal, even if the cases were sufficiently numerous, which they are not.

THE CRITICAL CASE.

But on the other hand, when two non-albino individuals have among their offspring one or several albinos, we can affirm, if Mendel's Law is exact, that these two parents are heterozygous DR; and we know that the proportion of recessives RR in unions between heterozygotes is 25 in 100, according to the formula DRxDR = 25% DD + 50% DR + 25%RR. In the pedigrees collected by Pearson, Nettleship and Usher, we shall therefore seek the cases where one or more albino children have been produced by normal parents; and we shall see whether their numerical proportion, relative to the total number of children born from those couples, accords with Mendel's Law.

It must be carefully noted that the theoretical figure, when we proceed thus, is not 25%, but a larger figure, separated the more widely from 25, in proportion as the number of children born to the couple is the smaller. For each of the children successively born to our heterozygous couple, there are indeed 25 chances in 100 or one chance in four that he will be an albino. But when the total number of offspring contains no albino, the case escapes our observation. If, for example, the phratry [3] consists of but one individual, the only phratries noted in our statistics are those in which this unique subject is an albino, and the proportion is therefore 100%. In phratries composed of two children, there is one chance in four that the eldest-born shall be an albino, there is also one chance in four that the second shall also be an albino, and consequently there is one chance in 4x4, or 16, that both subjects be albinos. On the other hand, there are three chances in four that the first-born be not an albino, three chances in four that the second shall not be an albino, either, and consequently 3x3 chances in 4x4, or nine chances in 16, that both the children be normal. But as these cases escape observation, there remain one phratry of two albinos in two children, and six phratries of one albino in two children, or eight albinos in 14 children—that is, 57 in 100. Continuing thus we find, for phratries of three, four, five, six, seven, eight, nine, 10, 11, 12, and 13 children, the figures of 43, 36, 33, 30, 28.8, 27.7, 27, 26.4, 26, 25.7, 25.5 (in 100)—a proportion that continually approaches the proportion 25 per 100, without ever reaching it.

Such are the theoretical figures, calculated according to Mendel's Law; we must now compare them with the figures contained in the genealogical work of Pearson, Nettleship and Usher. These figures are contained in the following table:

A No. of children in the phratry.	B No. of phratries observed.	C Total No. of albinos in phratries.	D Avg. No. albinos per phratry.	E Proportion of albinos in 100 children.	F Proportion of albinos per 100 (theoretical figures).
1	64	64	1	100	100
2	80	109	1.36	68	57
3	96	149	1.54	51	43
4	85	139	1.63	40	36
5	77	140	1.82	36	33
6	74	164	2.21	35	30
7	57	128	2.24	32	28.8
8	40	100	2.50	31	27.7
9	34	79	2.32	25	27
10	29	76	2.62	26	26.4
11	15	49	3.27	29	26
12	11	34	3.09	25	25.7
13	7	24	3.43	26	25.5

[3] For the sake of simplicity I thus designate the *ensemble* of brothers and sisters borne to the same parents. The English eugenists use the neologism *sibship* in the same sense, making use of the word *sibling* to designate each of the individuals making up a sibship, whatever be his or her sex.

It is obvious that, in a general way, the proportions found in the genealogies are quite close to the proportions calculated theoretically. It is noticeable that, in general, they are somewhat higher. It is not unnatural to conclude that some factor has come into play, which adds its influence to the hereditary factor ruled by Mendel's Law; should we invoke, beside the hereditary factor, a factor of *innateness*, as Lucas does? Perhaps, because it is certainly necessary that albinism should have appeared on some occasion, for the first time; perhaps this factor still exists, to add its influence to the factor of heredity. But to me another explanation seems more plausible. Note that the discordance only exists in the small phratries; it disappears in the phratries above eight subjects. I think it is because these researches do not represent the population in its entirety. I mean that the authors have gathered their material by collecting all observations published on the subject of albinism: now, it is very certain that not all cases of albinism are published, but only those which present some interesting particulars; among the interesting details which would lead to publication is the coexistence of several albinos in the same phratry, while an observer would easily pass without publication an observation relative to a single, isolated albino, unless he belonged to a very large phratry, in which case his isolation would itself be an interesting fact. In small families, the facts published by preference are those in which albinism appears relatively frequent; and it is in this manner that I should explain how the proportion of albinos found in small families is somewhat larger than the calculated expectation. It is probable that if the statistics could include all families in which albinism exists, the discrepancy—small, as it is—between observation and theory would be much diminished. We would then have only slight oscillations above or below the theoretical probability, as we have at present in the families of nine, 10, 11, 12 and 13 children.

To sum up: the figures brought out of the documents are in very close agreement with those required by the Mendelian law, or present only divergences explicable by the conditions under which the documents were compiled; and all these divergences are in the direction which the conditions lead us to expect.

We can even extend this agreement farther still. It is easy to calculate, from the mathematical law, the probability of the number of albinos in "albino phratries." Take, for example, the phratries of seven children. Calculation shows one chance in 14,198 that in these seven children there will be seven albinos; 21 chances in 14,198 that there will be six albinos; and 189, 945, 2,835, 5,103 and 5,103 chances in 14,198 that there will be five, four, three, two and one albinos in seven children.

Let us compare this calculation with the observation. In the work of Pearson, Nettleship and Usher, we find 57 albino phratries containing seven children each. One of these contains six albinos, four contain four, 18 contain three, 14 contain two and 19 contain one albino among the seven children. Calculating these figures on the basis of 100, to make comparison easy, we get the following table:

PHRATRIES OF SEVEN CHILDREN.

	Figures observed.		Figures calculated.	
	Absolute.	Percent.	Absolute.	Percent.
7 albinos	0	0	1	0.007
6 albinos	1	1.75	21	0.14
5 albinos	0	0	189	1.33
4 albinos	4	8.77	945	6.33
3 albinos	18	31.54	2,835	19
2 albinos	14	24.55	5,103	34.20
1 albino	19	33.33	5,103	34.20

I have arranged tables for the phratries of six, five, four, three and two children in the same way.

PHRATRIES OF SIX CHILDREN.

	Figures observed.		Figures calculated.	
	Absolute.	Percent.	Absolute.	Percent.
6 albinos	2	2.70	1	0.029
5 albinos	2	2.70	18	0.52
4 albinos	5	6.75	135	3.89
3 albinos	19	25.67	530	15.57
2 albinos	20	26.02	1,215	35.05
1 albino	26	35.03	1,458	42.05

PHRATRIES OF FIVE CHILDREN.

5 albinos	2	2.83	1	0.12
4 albinos	1	1.41	15	1.81
3 albinos	13	16.88	90	10.89
2 albinos	26	33.77	270	32.68
1 albino	35	45.45	450	54.47

PHRATRIES OF FOUR CHILDREN.

4 albinos	1	1.17	1	0.57
3 albinos	10	11.76	12	6.85
2 albinos	31	36.47	54	30.85
1 albino	43	50.58	108	61.71

PHRATRIES OF THREE CHILDREN.

3 albinos	13	13.68	1	2.70
2 albinos	26	27.36	9	24.32
1 albino	56	58.94	27	72.97

PHRATRIES OF TWO CHILDREN.

2 albinos	29	36.71	1	14.33
1 albino	50	63.29	6	85.71

If these tables are studied it will be seen that the discrepancy between the observed and theoretical figures is not noteworthy except in cases where this difference can be explained by the remark I made, that the figures of Pearson, Nettleship and Usher are not the result of a complete census, but of a collection of published cases, where the rarest instances figure in proportionately too large a number, and where on the contrary many common instances, such as that of a single albino in a family, do not figure. It will be noted that the discrepancies observed are always in the direction which this remark requires, and they are important only in the cases where their importance is explained by the circumstances under which the observation was made. That proves, then, the exactness of my explanation. On the whole, and taking account of these explanations, we may say that obser-

vation verifies the Mendelian proportions.

It seems to me difficult not to admit, as a consequence of these statistics, that albinism in man is recessive and obeys the law of definite proportions, established by Mendel.

The laws of Naudin and Mendel, then, are incontestably applicable to the human species, in this instance. Certainly, that does not prove that they apply equally to other anomalies. I should be very careful about drawing conclusions from this demonstration in albinism, about other family taints in man, whether they be of an anatomical, physiological or pathological nature. There will be no possibility of certitude, until each of these anomalies has been the object of an analogous study. However, if the case for albinism is proved, does it not at least render it probable that other anomalies behave in the same way, and should it not encourage us to pursue our researches in that direction?

Even before the discovery of the work, we knew that the mode of transmission of family defects presented curious particulars which allowed them to be classed in two groups: Féré proposed the name of *fraternal diseases* for those in which the heredity is collateral and discontinuous—that is to say, the mode of transmission proper to recessive characters; a second group, *parental diseases*, is transmitted on the contrary in continuous inheritance, in the manner of dominant characteristics. Is it not very probable that the inheritance of these diseases obeys Mendel's Law, the first being recessives and the second dominants? Shall we await a rigorous mathematical demonstration before trying to make any practical application of the principles which they involve?

POSSIBILITY OF APPLICATION.

In this respect, it is important to distinguish the practice of legal medicine from that of clinical medicine. Medico-legal truth demands absolute demonstration: I should take care, for example, in legal medicine, not to affirm a case of conjugal infidelity, if from the union of two albinos there was born, contrary to the Law of Mendel, a normal child; we are not yet well enough informed whether, in certain exceptional cases, extraneous factors may not interfere with the results which would be expected in such a case under the Mendelian Law.

But in the practice of clinical medicine, the case is different. There, we can not act as did the professor in the fable, and philosophize while the child drowns. The possibility of a danger, the probability of a benefit, is enough to give us not only the right, but the duty, of making the appropriate prescription as soon as possible: we thus have a chance of saving from this danger the families whose guidance is entrusted to us, or the hope of benefiting them.

It is from such a viewpoint that I formulated at the Congress in London some rules [4] which, in the present status of the science of eugenics, should be considered as allowing us to avoid the dangers to be feared in marriages of members of tainted family stocks, when these taints can be classified as to their mode of inheritance. I persist in thinking that these rules are of great value. For one of the diseases mentioned—albinism—a more rigorous demonstration has proved that they correspond to scientific truth. For the other diseases we have not yet, I admit, anything except a probability based on clinical observation which is often restricted, but often extended. This probability, however, is enough to make it impossible for us to disregard the rules which ensure the safeguard of strains of germ-plasm from family diseases.

[4] Following are the conclusions of my communication to the Congress of London, where these rules are formulated (they were also published at length in the *Monde Medical*, 1912, No. 459):

"To sum up, the study of heredity in family diseases permits us to lay down a certain number of rules which indicate the risks incurred in any given marriage. Such study permits us to withdraw the total prohibition of reproduction, demanded by writers who have studied the question only superficially—a measure too draconian ever to have been enforced. We are now in a position to substitute for such prohibition, advice that is more likely to be followed, because it leaves to the unhappy members of tainted families the possibility of leading a normal life,

ORIGIN OF THE DATE PALM

Fossils Found in Texas Indicate that it May be Native of America—Known Only in Orient in Historic Times—Its Connection with Semites and Its Religious Importance—Influence as Factor of Natural Selection.

THE EDITOR

FOR many years botanists have wondered where the date palm as a distinct species originated. Sentiment has seemed to incline toward North Africa as its first home, but the precise locality suggested has varied all the way from western Morocco to eastern Egypt; while the German botanist Schweinfurth declared his belief that *Phoenix spinosa* of tropical Africa was the species most nearly like the ancestral type of date palm, if indeed the latter was not a direct descendant of *P. spinosa*. The Italian botanist Odoardo Beccari, who is by general consent the authority on palms at present, considered the Persian Gulf to be the home of the date palm, and set forth[1] his position in such a logical way that the question seemed for a time to be settled.

"It is only in the orient," says Beccari, "that the true home of the date palm is to be found; in the orient where the true center of formation of the genus Phoenix is located and where the wild species most closely related to the domestic one—namely, *Phoenix sylvestris*—exists."

Beccari then elaborates his evidence in more detail. The home of the date palm must first be generally fixed by finding the home of its whole genus. The present distribution of Phoenix indicates that this must have been in India, according to Beccari's way of thinking. Next, the home of the date palm must be more definitely located, by a consideration of the physiological and morphological characters of the plant. We have a palm which thrives only in subtropical regions with scanty rains, but demands much moisture about its roots, and is remarkably tolerant of alkaline soils. Beccari thinks these facts may be taken to mean that the ancestral home of the date palm possessed similar characteristics. He therefore seeks its origin in a region of subtropical climate and

[1] Beccari, O. Malesia, III, 359. Firenze-Roma, 1886.

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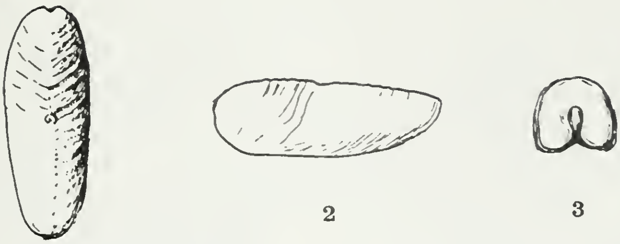
placing them under no restraint except that of judicious choice in marriage mating. These rules can be summarized as follows:

"*Diseases of parental heredity*: individuals who show no traces of the disease should not be the objects of any restrictive measures whatever; nor are consanguineous marriages particularly to be feared. . .

"*Diseases of fraternal heredity*: the malady may be transmitted in a latent state by all descendants of the affected subjects, or by their collaterals; but its chances of reappearing are much smaller than in the two preceding categories, these first two being of the dominant type. On the other hand consanguineous marriages, no matter how remote the degree of kinship, may be very dangerous in this latter category. As the disease may remain latent through a series of generations, one must go high in the ascendants, far in the collaterals, to be sure that an individual coming from an affected stock will marry into an untainted one. In such 'outcrosses,' the chance of a return of the disease becomes very slight." To this I added:

"In closing, I do not want to slight the fact that application of the rules thus established offers difficulties in many cases. The mode of inheritance has not yet been sufficiently determined for many family diseases. Some of them seem to fall in two classes. In such cases, it would be prudent to double the precautions."



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SEEDS OF THE AMERICAN DATE PALM

These fossil seeds were recently found in a Tertiary deposit of Texas, and give the first indication that the date palm, now confined to the eastern hemisphere, was at one time an inhabitant of America. They are considerably larger than the seeds of most commercial varieties of date known at the present day, but can be matched by seeds of occasional palms which have grown from seed, and show reversion. After Berry. (Fig. 6.)

scanty rainfall, close to the sea or some other body of salt water, this being a necessary condition to furnish the moist but saline subsoil for which the palm is evidently adapted. "This region," he concludes, "can only be sought to the west of India, in Southern Persia or on the Arabian coast of the Persian Gulf.

"To locate the original home of a cultivated plant, however, and to admit that it exists there today, are two different things.

WILD FORM NOT KNOWN.

"It is my belief that the date palm can not be found today in a wild state, because the nutritive qualities of its fruit are so great and the natural protection afforded to the flowers and vegetative parts is so slight, that it could not exist except by the aid of man. . . . The date palm can not be found except linked to the white human race. . . . No one should underestimate the importance which it must have exercised on the populations among which it prospered, in the preponderance which such populations were able to attain over others, as a result of the nutritious food, wholesome and plentiful, which the date palm furnished them."

But the recent discovery in a Tertiary deposit of eastern Texas of fossil dates has brought in an entirely new phase of the question, and strikingly illustrated the danger which surrounds all attempts to speculate on the data presented by systematic botany. Even scientists who looked on the western hemisphere as the original home of agriculture have never, so far as I know, suggested that the date palm was one of the products which America has furnished the world; yet the find of dates dating back several millions of years throws the burden of proof on those who would now hold otherwise.

The discovery of these remains was announced by Edward W. Berry of Johns Hopkins University in the *American Journal of Science* (May, 1914). He writes:

"The considerable range of species of Phoenix-like palms in the south European Tertiary has led to the expectation of their discovery in our more tropical southern Tertiaries when these should have been thoroughly explored, just as the Bread-fruit, Cinnamon tree and Nipa-Palm have been found; nevertheless, the actual proof of the former existence of a date palm in the Western Hemisphere is one of the more spectacular incidents of the paleobotanists' work, since it is likely to attract more attention from botanists and geologists engrossed in their own special lines of study than a tome of admirable descriptive paleobotanical work. In order that the presence of the date palm in

the American Tertiary may not remain unknown until my monographic studies of our southern Tertiary floras are published, which will be a number of years hence, I am prompted to publish the present brief note.

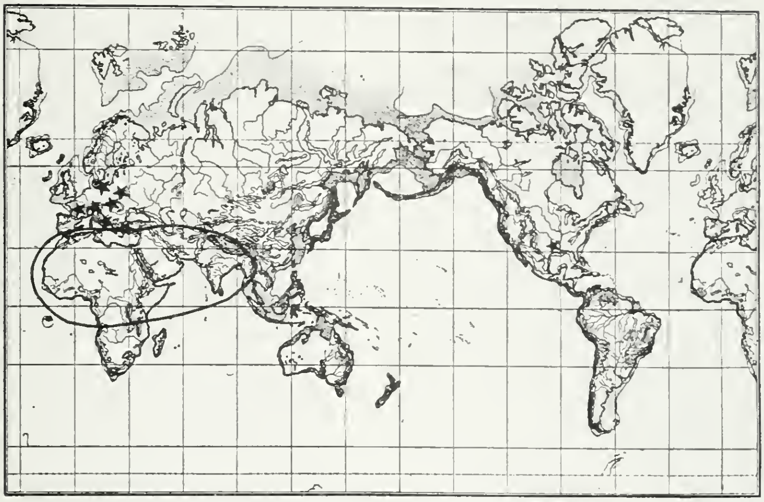
THE FOSSIL FRUIT.

"In the course of my studies for the U. S. Geological Survey and under the supervision of Dr. T. Wayland Vaughan, I have had the good fortune to receive collections of fossil plants from eastern Texas made under the direction of the veteran geologist, E. T. Dumble, now associated with the Southern Pacific Company. The material on which the following note is based was collected by Chas. Laurence Baker in Trinity county, Texas, and while not abundant contains both large and small seeds and a cast of the entire fruit of a new species of Phoenix-like palm which may with propriety be referred to Brongniart's genus Phoenicites. I propose to call this species *Phoenicites occidentalis*. It may be described as follows: Fruit, as preserved in a coarse gray sandstone, an oblate spheroid about 4 cm. in length by 1.5 cm. in breadth. The surface is longitudinally wrinkled, due possibly to dessication before preservation, which may also make the dimensions as given under what they were in life. The flesh was relatively thin compared with the cultivated date and must have been of considerable consistency and fibrous rather than of the soft and almost fluid character of some of the modern varieties of the latter. The seed was relatively large—in the above-mentioned specimen it is rounded at both ends, about 3 cm. in length, nearly circular in transverse section and about 1 cm. in diameter. A smaller specimen shows a length of about 2.5 cm. and a diameter of 8 mm. The larger of these seeds shows the central hilum, the deep longitudinal sinus on the opposite side, the transverse lamellated structure exactly comparable to that of a modern date seed and the finely corrugated surface coat identical with that of a dried seed of a modern date. The smaller specimen, while not so perfect, shows the general form and sinus and the lamellated structure. There can be no doubt that these remains are those of a Phoenix-like fruit and it is confidently expected that the foliage will eventually be discovered, in fact some of the fragments of palm-rays found at this and other horizons in our southern Tertiary may represent this foliage. Petrified wood of several species of palms is exceedingly abundant in these beds, and while the study of palm woods has not progressed to a point where one can speak with certainty of the generic relations of the petrified woods, it is significant that wood of several different species occurs at this horizon.

FOSSILS FROM EUROPE.

"While the geologic record is confessedly incomplete, a number of fossil species of Phoenix-like forms have been described, in fact there are more fossil than recent species. These are usually referred to the genus Phoenicites of Brongniart as in the present case, although some students refer them directly to the genus Phoenix of Linné. The previous fossil occurrences are all European and are based on leaves and inflorescence. In 1886 Conwentz described a flower preserved in perfection in the Baltic amber and the staminate inflorescence of another species is associated with splendid leaves in the Eocene of the Paris basin. The oldest known comes from the upper or middle Eocene of the Paris basin, while in the succeeding Oligocene period the remains of date palms are abundant in Germany, Bohemia, and especially in northern Italy. They are present in the early Miocene of France, Switzerland and Croatia. A species is recorded from the west coast of the Adriatic in Pliocene times and the presence of a well-marked form which Drude calls *Phoenix dactylifera fossilis*, since it is so much like the existing date, is found in the Pleistocene deposits of the volcanic island of Santorin in the Aegean Sea. The latter occurrence indicates that the date palm was endemic in at least a part of southern Europe until comparatively recent geologic times.

"A consideration of the ecology of the date and of other existing species of



THE RANGE OF THE DATE PALM

The present range of the date palm is in the territory circumscribed by the heavy line. No account is made of America, since the palm has only been introduced here within a relatively recent time. The stars show localities from which fossil remains have been taken, indicating that in the prehistoric period the palm was much more widely spread than at present. After Berry. (Fig. 7.)

Phoenix, at least two of which are coastal types, indicates that the geologic ancestors were not necessarily desert types, but inhabitants of coast and stream-banks where the water-table approached near enough to the surface to become available for their root system. When corroborated by the associated forms of vegetation they may indicate hot climates with a scanty rainfall as they probably do in east Texas and it seems certain that temperatures could not have gone below 18° C. without being fatal.

"*Phoenicites occidentalis* comes from a cut on the International and Great Northern Railroad in southern Trinity county, where a spur to the government lock leaves the main line. The outcrop is referred to the Catahoula formation, which in this region is of late Eocene or early Oligocene age."

MIGRATION OF THE PALM.

Why the date palm became extinct in America, and how it spread to the Eastern Hemisphere, one can hardly guess, but as such a history is matched by that of numerous other plants and animals known to us, there is nothing improbable in it. As far as our historical record goes—and for the date palm it goes back very close to the beginning of history—the palm has been associated with the Semitic peoples, so that it has come to be considered an integral part of their culture.

Far earlier than any of our written records we must picture the date palm as established in the Persian Gulf and Babylonia, and forming an important part of the food of the inhabitants of that region. Its fruit in that period doubtless consisted of much seed and little flesh, like the Texas fossil and like the fruit of *Phoenix sylvestris* and many seedling dates today, for in that early period we can hardly suppose that the propagation of superior varieties by offshoots was practiced. By the time, however, of the famous Hammurabi (c: 1958–1916 B. C.) there is evidence that propagation by offshoots was the customary means of starting a plantation. The sixtieth paragraph of that monarch's code of laws provides that, if a man lease his garden to another to plant as an orchard, he shall let it without rent for four years, but in the fifth year the owner shall have half

the crop. There are several contracts of the period of Hammurabi, which relate to orchards, all of which mention dates as the principal, indeed the only fruit, crop. The natural inference is that orchards in Babylonia always contained dates, and that planting an orchard meant getting palms ready to bear. Four years, then, was the time allowed for this—a limit that makes vegetative propagation absolutely necessary.[2] Indeed, if the Babylonians could get a paying crop in the fifth year, they did better than most Arab cultivators do today in Babylonia, although Californians expect to do as well as that, by the use of scientific methods.

Scholars now believe 5000 B. C. to be as early as any settlement in Babylonia can be traced. Even at that time, however, dates must have been one of the most important products, as they perhaps were to the Semites in their earlier Arabian home some thousands of years previously. When we first begin to get written records from Babylonia, we find that the palm holds a prominent place. One of the oldest tablets in the world is a Babylonian fragment now in New York, which may go back to 3000 B. C., and contains a rude picture of a date palm, in connection with a memorandum of an offering to some temple.

THE DRINK OF LIFE.

At that period, and doubtless far earlier, the palm was valued not only for its fruit, but perhaps almost as much for the beverage which its sap furnished. This appears in early inscriptions under the name of "the drink of life;" "as far back as the period of the formation of the cuneiform script this was the name given to the date wine of Babylonia," says Sayce. Beccari interestingly discusses the way in which the possibility of producing an intoxicating liquor from the palm came to be known. "That primitive man could at a very early period discover the manner of obtaining a fermentable liquor from the date palm is easily understood," he thinks. "When he learned that by cutting out the terminal bud of the palm he obtained a delicious food, he also found that as a result of that operation, a sweetish liquid flowed abundantly from the wound. Nothing more natural, in a country where water is scarce, than that this liquid should have been caught in some kind of a receptacle and used for drinking. But in the meanwhile the liquor fermented; and thus perchance, earlier than the juice of the grape, man may have learned the method of making alcohol, and to feel the effects of its inebriating power."

Beccari is no doubt right in emphasizing the tremendous importance this discovery must have had, as an agent of natural selection. While palm wine is not to be compared with distilled liquors, in alcoholic content, it yet contains so much alcohol, when fermented, as to be decidedly dangerous. The French have recently prohibited its manufacture in Algeria, partly because the natives were destroying their plantations in order to satisfy their appetites for alcohol, but largely because the beverage led to incessant breaches of the peace. The influence of alcohol in injuring germ plasm is becoming better attested each year, yet most of the germ plasm now exposed to its ravages has gone through centuries of natural selection, when the strains which showed the least resistance to it were cut off. The havoc that must have been wrought by palm wine, when first discovered and used by a people who had never undergone any selection against alcohol, can only be imagined by remembering how the American Indian fared under similar circumstances.

THE MYSTERY OF SEX.

Added to its value as a producer of food and drink, the date palm possessed another element of intense interest to the dwellers of Babylonia and the shores of the Persian Gulf in its dioeciousness—female and male flowers being borne on different palms. The

[2] See R. F. Harper, The Code of Hammurabi, p. 53, 1904, and Schorr, Urkunden des altbabylonischen Zivil-und Prozessrechts, pp. 189–194, 1913. I owe this and numerous other valuable suggestions to Dr. Geo. A. Barton of Bryn Mawr College.

POLLINATION OF THE PALM

Conventional design of a type particularly frequent in the palace of Ashurnasirpal (883–859 B.C.) at Nimrud (Ninevah). While orientalists do not agree on the interpretation of the figure, there is reason to believe that the winged deity represents the palm god, and that he is holding in his right hand a male inflorescence, with which he is fecundating the female flowers. Because of its dioeciousness, the palm early came to symbolize the reproductive force of nature, for the Semitic peoples, and thus assumed an important place in their religion. After Siret. (Fig. 8.)

mystery of reproduction always occupies the minds of primitive peoples, and here was a particularly striking case, where the process of fecundation could be watched, or even carried out by the agency of man, and where the difference in result, as the female was or was not pollinated, was marked. The date palm, already valued as producing the best food, and the "drink of life," come to symbolize the creative force of Nature, and the next step, details of which are not wholly clear to us, led to its firm establishment as the "tree of life," an object of actual worship—or at least, to its identification

with that primitive Semitic goddess, who herself symbolized the creative force of nature.

We are still dealing with a very remote period of human history, and the records which have come down to us are fragmentary, but we have enough to get a general view of the date palm as the center of a cult of immense antiquity. Our earliest records show this cult centered in the town of Eridu, only a few miles from that Ur of the Chaldees (Mughayr of modern maps) whence Abram migrated, and at present about 90 miles from the head of the Persian gulf. It was then a seaport, however, and calculations of the rate at which the Tigris and Euphrates have deposited silt indicate that it must have been a seaport about 7000 years before Christ. This was long before the immigration of the Semites, ancestors of the Hebrews and Arabs, who later spread over Babylonia. Their station was perhaps at Eridu, which owned its renown less to that fact, however, than to its being the home of the oracle-tree, the Tree of Life, whose position in a garden near the town marked the center of the world. This tree was a date palm.

"The garden and its mystical tree were known to the inhabitants of Chaldea in pre-Semitic days," Sayce notes.[3] "A fragment has been preserved of an old Accadian-Sumerian hymn with a Semitic Babylonian translation attached to it, which tells us something about them. The hymn begins as follows:

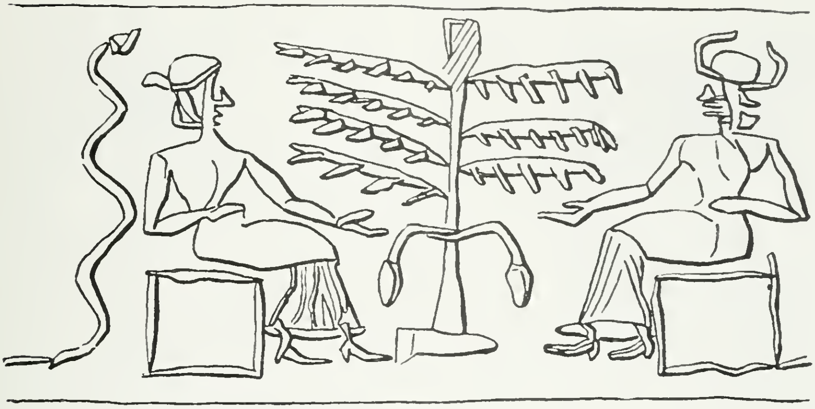
> In Eridu a palm-stalk grew overshadowing: in a holy place did it become green;
>
> its root was of bright lapis which stretched toward the deep: [before] the God Ea was its growth in Eridu, teeming with fertility:
>
> its seat was the [central] place of the earth; its foliage (?) was the couch of Zikum, the [primeval] mother.
>
> Into the heart of the holy house which spread its shade like a forest hath no man entered.
>
> [There is the Home] of the mighty mother who passes across the sky.
>
> [In] the midst of it was the god Tammuz.

"The sacred tree whose branches reached the heaven while its roots were nourished by the primeval deep was the tree which supported the world. It was emphatically a 'tree of life' and is accordingly represented time after time on the monuments of Babylonia and Assyria."

When the Semites from Arabia invaded Southern Babylonia, at a date beyond the scope of historical knowledge, they must have found the date palm already established there, even if not cultivated; Barton, indeed, suggests[4] that they established themselves at Eridu as their first station, because they found at that place their old friend, the date palm. If this be the case, it may be assumed that the culture of the palm in some of the valleys of the Arabian shore of the Persian gulf represents the oldest form of agriculture in that part of the world. There is reason to believe that in their earlier, Arabian home the Semites had already accorded divine honors to the date palm; and in Babylonia the cult seems promptly to have become widespread and well organized. It spread gradually to the north, finally reaching the Phoenicians and residents of Syria; in all these regions the Tree of Life became a regular factor in decorative art, reaching its greatest vogue, perhaps, in the kingdom of Assyria about the ninth century before the Christian era, when the huge palaces of Nimrûd (Ninevah) were constructed, in which the palm tree and the supposed palm god figure at every turn. The Tree of Life, sometimes so conventionalized as to be almost unrecognizable, was also used in the interior decoration of temples, on city gates, on royal vestments, seal cylinders, and everywhere else that the artist could bring it in. The exact interpretatior of the designs has given rise to much controversy; it is not of great importance to us, so long as we know that it is the date palm which is represented.

[3] Sayce, A. H. The Higher Criticism, p. 100. When Sayce wrote, it was still believed that the Semites were late arrivals in Babylonia, and that the original inhabitants were the Sumerians, a race which probably came down the mountains to the northeast, and has been thought by some to be an Aryan, by others a Mongol or Turanian, stock. Eduard Meyer in his Sumerier und Semiten in Babylonien, 1906, proved to the satisfaction of most scholars that the Semites were the original inhabitants.

[4] Barton, G. A. A Sketch of Semitic Origins. New York, 1902.



THE SO-CALLED ADAM AND EVE CYLINDER

Design from a seal cylinder now in the British Museum. It is of unknown date, but apparently belongs to an early Babylonian period. It has given rise to more controversy than any other seal cylinder ever found, one school of orientalists, led by George Smith, seeing in it a representation of Adam and Eve before the Tree of Life, with the serpent at the left, while others, including Menant and Ward, think it has no reference to the account of the fall of man contained in Genesis, but represents rather two deities of production, Ningirsu and Bau. Whatever be the interpretation, it is at least obvious that the tree in the center is a date palm. (Fig. 9.)

E. B. Taylor[5] is credited with the enunciation of the theory that the designs symbolized the artificial pollination of the palm. The interpretation was generally accepted, and a late legend was also brought forward, which explained the figures by the story that they were gods which had taught man how to produce dates by artificial fecundation. Bonavia, in his "Flora of the Assyrian Monuments," considered them to be the winds, agents of pollination in nature. Siret[6] and others interpret them as human personifications of the palm itself—the palm-god, the palm in the form of a god with a human figure. Siret thus explains the fact that they are usually winged:

"The essential morphological character of the palm, which distinguishes it among all other trees, is its leaves; in anthropomorphizing it, these could not be suppressed; but as leaves could not very well be represented on a human body, these leaves which are not very dissimilar to feathers, are represented as feathers, which are grouped together as wings. Such a grouping in itself is not arbitrary: look at a row of palms carrying all their leaves. It will be noted that horizontal leaves are rare, because as soon as they reach that position, their weight rapidly pulls them down; accordingly they divide into two groups, one pointing upward, the other downward. Such are the wings of the Assyrian deities, the one raised, the other lowered."[7]

IN THE GARDEN OF EDEN.

As we approach nearer to strictly historic times, and the records which have come down to us become fuller, we get more and more light on the importance of the palm in the life of Semitic peoples. The most interesting manifestation of it, seen by some orientalists, is in the story of the Garden of Eden related in the first chapters of Genesis.

We know that Edin was, from the

[5] Nature, June 23, 1890; Proc. Soc. Bib. Archeol., 1890.

[6] Siret, Louis. Les Cassitérides et l'Empire Colonial des Phéniciens. L'Anthropologie, XX, 292. Paris, 1909

[7] As a matter of fact, the very earliest seal-cylinders, in representing winged animals and man, show them merely with palm leaves attached to their shoulders. There can thus be little doubt as to the significance of the wings in the minds of the later artists.

dawn of history, the name for the alluvial plain of the Tigris and Euphrates rivers at the head of the Persian gulf. The Semites and Sumerians alike used it. Equally widespread, as we have seen, was the tradition of a Tree of Life at Eridu in Edin—a tradition which survived in tangible form down to a late day, through the presence of an oracle-palm on the same spot. Now the theory put forward by Sayce, Hommel and other orientalists is that the Biblical account of the garden of Eden is derived from this same tradition of venerable antiquity, about the Tree of Life at Eridu.

"The garden with the tree of life in the midst was planted 'in Eden eastward,' for such is the correct rendering of the Hebrew text," declares Sayce, "and not 'eastward in Eden' as the Authorized Version has it. Not only the garden, but Eden also, lay to the east of the land where the writer lived— The garden stood hard by Eridu, 'the good city'—and thus in the very region where the salt 'river' of the Persian gulf was divided into its four heads" mentioned[8] in Genesis II, 10-14.

Not all orientalists admit that the date palm of the garden in Eden at Eridu was the origin of the Tree of Life and Tree of Knowledge of Good and Evil of Genesis; but at least there can be no doubt that the date palm remained an object of particular veneration to the Hebrews after they left Babylonia for Palestine. It was a chief motif in the decoration of Solomon's temple, while its sacred character is suggested by the fact that the prophetess Deborah had her seat under a date-palm, from which, inferentially, she derived inspiration. Barton sees in the Feast of the Tabernacles a survival of an earlier Semitic feast at the time of the annual date gathering.

AMONG THE PHOENICIANS.

Far before this period of the Hebrew kingdom, the Phoenicians possessed the cult of the palm, and carried it with them on their trading voyages. Numerous plaques and pieces of pottery have been unearthed in France and Spain, bearing date palm symbols, while in a domed sepulchre at São Martinho, Portugal, considered to date from the late Stone Age, a limestone cone was found identical with the burnt clay cones made in Babylonia and Assyria as images of the fecundating spathe of the male palm. These relics can be ascribed with a good deal of certainty to the visits of Phoenician ships in search of tin; while their influence in shaping the religious thought and forming the myths of all the peoples of the Mediterranean seems to many writers to have been great. Siret has elaborated this point ingeniously and interestingly, but it is too far from the field of genetics to warrant amplification here; I need only say that he finds traces of the palm cult in nearly all the Grecian deities, one particularly attractive conjecture being his explanation that the story of the visit of Zeus to Danae in the form of a shower of gold is merely a modification of the idea of the male palm fecundating the female with its shower of golden pollen. The case of Leto (Latona) who gave birth to Apollo beside a palm tree in the island of Delos, is a curious instance of the survival of the palm cult, from his viewpoint; and it is still more curious when one recalls that the legend, slightly changed, was applied to the birth of Jesus in the apocryphal "History of the Nativity of Mary and the Infancy of the Savior," which Muhammad, much later, seems to have used in the Koran as the source of his own account of Christ's birth under the palm tree, and the appearance of the angel Gabriel who bid Mary eat the fresh, ripe dates to refresh her soul. Tisdall ascribes[9] the story to an Indian origin, pointing out the markedly similar circumstances surrounding the birth of Buddha under a satinwood[10] tree, according to legend;

[8] Hommel identifies the river Hiddekel of Genesis with Khadd Daqlah, "The Valley of Date Palms" on the Arabian shore of the Persian gulf not far south of the present mouth of the Euphrates and Tigris rivers. Hiddekel is by most scholars taken to mean the latter of these two great rivers.

[9] Tisdall, W. St. C. The Original Sources of the Qur'an, p. 164. London, 1905.

[10] *Chloroxylon sweetenia*, D. C. Rutaceae.

THE GODDESS ISHTAR AND PALM

"There is hardly a more beautiful and elaborate Assyrian cylinder than one in the British Museum which represents the armed Ishtar," says W. H. Ward (The Seal Cylinders of Western Asia, p. 248). She is here shown as the goddess of war, standing beside the palm. Originally, in the opinion of many orientalists, Ishtar (Astarte) was the goddess of fertility, and identified with the date palm, which at a very early time seems to have received almost divine honors from the Semites—a condition of which traces can be seen throughout the later Arab and Hebrew history. This and the preceding design are from Jastrow, Bildermappe zur Religion Babyloniens und Assyriens. (Fig. 10.)

but in view of the sacredness of the date palm in all times, it is by no means clear that we should abandon the idea that this myth represents a late out-cropping of the palm-cult, rather than a borrowing from Indian literature.

All this is wandering far from the culture of the palm, yet the sacred character with which the early Semites invested it is too striking to be ignored. It is found in many sources. Tabari, an early Arabian chronicler, for instance, refers to a sacred date palm at Najrân, in southern Arabia, which was treated in all respects as a god; the residence of Al Uzza, one of the principal deities of pre-Muhammadan Arabia, was in a grove of palms at Nakhlah, a name which itself means palm tree; while an interesting light is thrown on the Biblical story of the Garden of Eden, and the accounts preserved for us of the tree of life at Eridu, by a passage in the oldest portion of the bock of Enoch, in the version of the Ethiopians—a people of Semitic relationship. This passage, which probably dates from the second or third century before Christ, describes a visit of Enoch to Paradise, and relates that he found there the Tree of Life—and it was a date palm.

BAAL, THE PALM GOD.

In the heathen gods of whom we have some Bibilical account, it is frequently easy to see traces of the date palm cult. Few of them are better known to us than Baal; and the word *baal* even today, in classical Arabic, means an unirrigated palm tree. The connecting links between this fact and the time when Baal was looked upon as the god of unirrigated land, in contrast to Ishtar or Astarte, who was the primitive Semitic goddess of the palm, of fertility and fecundity, are traced with skill by Barton. No wonder, with such unbroken traditions, that the palm has always been looked upon with veneration by the Arabs, the purest of modern Semites; so that Muhammad declared it to have been created from the soil left over after the creation of Adam; and no wonder that the Arabicized Berber in remote Morocco even today mutters an Arabic prayer as he performs the important

operation of pollinating the female inflorescence by shaking over it and tying in it a few sprigs from the male flower.

Turning again to genetics, the outstanding fact in the culture of the date palm is the immense number of its horticultural varieties, and the antiquity of many of them. It is probably safe to say that there are not less than 5000 named varieties, in the subtropical regions of the world, and we have records of a number of them in Arabic literature, which prove them to be at least 1300 years old. During all this time they have been propagated vegetatively; nevertheless, Arabs declare that some of them have undergone large changes in the intervening centuries. The evidence at hand is not sufficient to constitute proof, and it may be that earlier varieties have died out and their names been assigned to other varieties with different characters. Personally, however, I think we must admit the possibility that some of the varieties have undergone changes analogous to those bud variations which have played so important a part in the history of the navel orange and many other fruits. It is not difficult to imagine an offshoot varying from its parent; when this was planted, if the variation was found to be favorable, it would continue to be propagated until the new type had supplanted the old one, without any change of name.

The fewest varieties (and in my opinion the best[11]) are found at present in the Persian gulf and Babylonia. All over the world the varieties are found to be quite local in distribution, but when one reaches North Africa, their number is greatly augmented, through the multiplication of chance seedlings. Darwin, to emphasize the way in which "organic beings of all kinds, when domesticated or cultivated, have varied," noted that "in the deserts of northern Africa the date palm has yielded 38 varieties." If he had multiplied this number by 10, he would still have been below the truth. There are probably a hundred varieties of commercial importance there, and a host of minor ones, almost every chance seedling in some districts being given a varietal name, if it happens to be a female. In Spain, the confusion becomes so great that varieties can scarcely be said to exist, each palm being a variety by itself. This seems always to have been the case in Spain, even in the time of Pliny, and may be confidently ascribed to propagation by seed, without sufficient care in selecting, rather than to the climate or any other environmental influence.

[11] Exception should be made in favor of Deglet Nûr, "The Date of the Light," a variety which originated as a chance seedling near Tuggurt in the Algerian Sahara 300 years ago and has since become recognized throughout North Africa as the standard of excellence. In the extreme desert conditions which it requires, it is perhaps as good as any variety in the world. Orthodox Arabs consider the dates of Medina, the prophet's home in Arabia, to be the world's finest, but until they have been studied by some competent pomologist, this verdict must be ascribed largely to religious enthusiasm, fostered by the legends connecting Medina dates with Muhammad. See Popenoe, Paul, Date Growing in the New and Old Worlds, 1913.

The Power of Heredity

Wise reform will not fail to recognize the force of heredity, whether for the continuance and multiplication of human ills, or for their diminution. It will do but little good to work for individuals here and there. Such conditions must be created as will redeem the human life-stream itself. It may be that the greatness of this task will stagger the thought and shake the courage of some. It is scarcely to be denied that the study of human nature as conditioned by heredity and environment is depressing in its initial stages. It makes humanity seem like clay in the hands of an inexorable and remorseless potter; but it will save an immense waste of time, effort and means, and, by and by, the depression will change to hope, as it is seen that the same law which necessitates degeneration under certain conditions, under other conditions works regeneration.—Rev. Amory H. Bradford: Heredity and Christian Problems (1895).

STUDY OF OLD AMERICANS

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OF THE many ethnic groups which are now entering into the formation of the American nation, the least known to science is that of the old white American. By the "old American" is meant the lineal descendant of American parentage, on both the father's and mother's side, for at least three generations; in other words, he who is not merely himself a native of the United States, but whose father and mother and both grandfathers as well as both grandmothers, were born in this country. This old and most important stock has never been studied exclusively. How strong is it in numbers? What physical changes, if any, have been wrought in its representatives by the new environment, the more strenuous mode of life, and the mixture of the various elements of which it is composed? Has it been changing so far as its anatomical and physiological characteristics are concerned harmoniously with the old world stocks from which it arose, or has it progressed differently? Does it tend towards a new subtype of the white race, as has often been suggested? What are the average stature, weight, head and chest dimensions, temperature, pulse rate, respiration and muscular strength of these old Americans? What the prevailing color of their eyes and hair?

In order to approach a definite answer to these and other questions which are of wide national interest, as well as scientific importance; and in order also to establish much needed standards for future comparisons, there are being carried out in the Division of Physical Anthropology of the U. S. National Museum, a series of scrupulously careful tests and measurements on healthy adult Americans of three or more generations, of both sexes, and of between 24 and 60 years of age. Persons fulfilling the requirements indicated above and wishing to forward the investigations in question are respectfully invited to present themselves, when convenient, for examination. The study, to be of real value, must extend over at least 200 men and 150 women, and it would be difficult to reach these numbers without the voluntary aid of those interested. No selection of subjects is called for outside of the above named stipulations, namely: that they shall be healthy, between 24 and 60 years of age, and on both sides American for at least three generations. The examinations are conducted under my own direction, and those who wish to present themselves for the measurements may do so at any time between 9.00 and 4.30 p. m., or by appointment after 4.30. The whole examination lasts but a little over a quarter of an hour, and no unusual exposure of the person is called for, with the exception of removing the shoes while the height of the body is measured, and in ladies the loosening of the hair for the measurements of the head. No names will be published in the final analysis and publication of the data. The original data will be kept in the U. S. National Museum and will be available to all of those who have been measured, and to their children.

The measurements comprise those of stature, head, face, chest (over the clothing), ear, hand and foot; tests are made of the muscular strength; the temperature, pulse and respiration are recorded; and the examination terminates with a few observations of the color of the hair, eyes, and the most distinguishing marks of the features.

The laboratory of the Division of Physical Anthropology is located in the new building of the National Museum; telephone number, Main 1811, branch 89.

A DEGENERATED ROSE BLOSSOM

Every horticulturist knows that the floral organs of any plant, such as the sepals of the calyx, the usually bright-colored petals, stamens and pistils, are all only so many modified leaves, and that under certain conditions leaf-buds can be turned into flower buds, at an early stage of their existence. Thus, by crippling the plants, gardeners force azaleas or camellias to produce flowers from the buds which the plants had intended to produce only leaves. The rose is a particularly good plant in which to trace this development, for it from time to time throws out flowers that fail to attain their normal development, and are nothing more than modified leaves. A bush on my estate has been behaving most irregularly for two years, always sending out freak flowers under certain weather conditions. Sometimes the roses are only half developed, just as if they were cut in two. Last spring it produced several twin flowers, later on some flowers that were lopsided, and on August 3 I noted the branch here photographed, in which the sepals have reverted to their original leafy character, clearly showing the pinnate margin characteristic of the species. The petals, too, although partly colored, were morphologically more like leaves than like the ordinary petals of a rose. Such phenomena are particularly common in cabbage roses; probably they are connected in some way with excess of nutrition, in many cases at least. Reversions such as the one photographed give striking proof, if any were needed, that flowers are merely modified leaves. (Fig. 11.) JOHN C. UHRLAUB, Glenbrook, Connecticut.

CORN AND MEN

The Interacting Influence of Heredity and Environment—Movements for Betterment of Men, or Corn, or Any Other Living Thing, One-sided Unless They Take Both Factors into Account.

Albert F. Blakeslee

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EUGENICS deals with racial improvement by means of heredity in contrast to the subject recently termed Euthenics which deals with improvement by means of the environment. These two influences —heredity and environment—together are responsible for the great diversity found in all living beings. It is this diversity in mankind that gives us our educated and our uneducated classes, our geniuses and our imbeciles, our lawmakers and our law-breakers. Successful and unsuccessful men, as well as successful and unsuccessful corn plants, are such because of the resultant influence of these two factors.

Both heredity and environment are always in play. Their distinction and their relative influence must be carefully estimated in any rational campaign for permanent social improvement. Our ideals and practice in social and religious justice, rewards and punishment, charity and education, are fundamentally dependent upon our estimate of the relative value of these two factors—environment and heredity. If one is born with inherent criminalistic and anti-social traits, the environment may be in no way responsible and can thus be neglected. Shall we, however, merely punish the individual or shall we attack the real cause of the crime—his heredity? On the other hand, if the criminal is made such by his environment, shall we confine our attention to the criminal and neglect the environment which has made him criminalistic?

A specific instance may make the questions clearer. In our past crusades against the social evil, we have too often sought legislation before investigation We have had recounted to us the pitiable struggle of the poorly paid wage earner, the influence of the saloon and of the dance hall. The downfall of fallen women has been attributed to these environmental conditions. If this is so, a cure for the evil would be simple, though difficult—namely, the removal of the bad environment. On the other hand, the family histories of these wayward girls have received little attention. Evidence, however, has been recently presented to indicate that moral waywardness is inherited in much the same manner as other mental defects—that moral deficiency runs in families. If heredity is the sole cause of the social evil, the remedy—the removal of the bad heredity—is obvious, but has not yet been seriously attempted. In endeavoring to heal this moral disease, need we attack more than one factor, or are these two—environment and heredity—of such influence that both require combatting? Such questions may bring home the need of knowledge of how these two fundamental factors act, before hasty attempts are made at social reform. A safe watchword is—Information before Legislation.

INTEREST IN GENETICS.

The comparatively recent discovery that knowledge of the laws of biology may be used in the improvement of cultivated plants and domesticated animals furnished the necessary human interest to bring the subject of Genetics into popular appreciation. The realization, further, that man himself is subject to the same laws of life as other animals has merely heightened the in-

Number of individuals in each rank	1	0	0	1	5	7	7	22	25	26	27	17	11	17	4	4	1
Heights in feet and inches to which ranks correspond	4:10	4:11	5.0	5:1	5:2	5:3	5:4	5:5	5:6	5:7	5:8	5:9	5:10	5:11	6:0	6:1	6:2

AN INTRODUCTION TO BIOMETRY

Company of students at Connecticut Agricultural College, grouped according to differences in height. The height of each rank, and the number of men in that rank, are shown in the figures below the photograph. The company constitutes what is technically known as a "population" grouped in "arrays of variates;" the middle array or row gives the median or average height of the population. If, now, a line be drawn connecting the upper ends of each row, and another line be drawn along the front rank to serve as a base, the resulting geometric figure forms a "scheme of distribution of variates" or more briefly, a "variability curve," since if the number of arrays were larger, the line joining their tops would form a perfectly smooth curve. The arrangement of homogeneous objects of any kind in such form as this is the first step in the study of variation by modern statistical methods, and on the study of variation much of the progress of genetics rests. (Fig. 12.)

terest which has been aroused by the application of scientific knowledge to plant and animal breeding. The most interesting study of mankind may be man, but in biology at least this study must make large use of the indirect method, employing plants and rapidly breeding animals for experimental purposes. The present article is to call attention to the fundamental differences between heredity and environment and to illustrate the subject by a comparison between the growth of corn and of man. The discussion will deal with a single comparatively simple characteristic—height. Something will be said about the manner in which a single character of this kind may vary among a group of individuals, and the influence of environment and heredity in bringing about these variations will be discussed.

Variation is universal among living organisms. It applies to individuals and parts of a single individual. A class of students after examining hundreds of apple leaves in the attempt to find two that are identical is willing to admit that no two leaves exist exactly alike. We are grateful indeed that in man no two persons have the same mental make-up. Differences in man's physical features as well as in his mental equipment are easily recognized and more readily analyzed. The relatively simple and obvious character of height may well serve for analysis. Each of the 175 students shown in Figure 12 was measured in his stocking feet and placed in the rank to which his height most nearly corresponded. Only one student was shorter than 5 ft. and only one could be placed higher than the 6 ft. 1 in. rank. The great majority are in the middle ranks 5 ft. 6 in. to 5 ft. 8 in. The extremes are rare, the average is common. Most of us are just average people, neither extremely tall nor short, fat nor slim, fast nor slow, rich nor poor.

Teachers know that differences in mental ability follow the same laws as differences in height. The majority of a class are average students. Few are unteachable and few gain the highest ranks that may be obtained.

If the ends of the ranks in the photograph were connected by a line we should have a typical curve of variability. Such a curve shows the distribution of the different heights in the company—the manner in which the individuals vary—but gives no definite clue to the causes of the differences which are found to exist.

WHY MEN GROW TALL.

Two general causes have been assigned to account for the differences in individuals brought to view by a variability curve, namely, environment and heredity. The first would assume that differences in height were due to differences in surroundings during growth; the tall boy is tall, it would be claimed, because he has been well nourished and cared for; the small boy is small because his growth has been checked by disease, accident, or insufficient nourishment. The second suggested cause, heredity, would assume that the differences in height are due to differences in the gifts of inheritance with which each individual began life; a tall boy is tall, it would be claimed, because tallness ran in his family, a short boy is short because his parents or less immediate ancestors were small of stature.

Differences in environment or in heredity, acting either alone or in combination, will be able to cause variation in a group of individuals. If these individuals are arranged in ranks according to the variations which they show in a single characteristic, they will present such a variability curve as is shown in Figure 12. Mere inspection of the curve, however, will not enable one to discover which factor is the predominant or exclusive cause of the variations. For this a study of the ancestry of the individuals and of the effect upon them of the various environmental conditions to which they are exposed will be necessary. A discussion of the corn plant will be appropriate in this connection.

In the Agricultural Botanic Garden at Storrs, Conn., a section is devoted to plots illustrating the laws of genetics. Differences in height and general vigor of plants are classified as due either to

THE INFLUENCE OF ENVIRONMENT ALONE

Corn of a single variety (Leaming dent): at the left, grown well spaced in hills, at the right badly crowded. The heredity of each plot of corn is the same; the striking differences in growth, and marked differences in reproductive capacity which are not seen in the photograph, are therefore solely due to environment. By avoiding the bad environment (*i.e.*, the crowded condition) the grower might have had corn in the plot on the right, just as big and vigorous as that on the left. If, however, he had planted some such variety as Tom Thumb pop corn on the right, it would have remained small no matter how good the environment provided, because of its heredity, which prevents it from being anything but small. The attempt to disentangle the influences of heredity and environment is one of the most perplexing problems in breeding, as in race betterment, but failure to attempt it leads to disastrous results. (Fig. 13.)

differences in external conditions under which they are grown, *i. e.*, to environment or to differences in their parentage, *i. e.*, to heredity. Figure 13 shows two plots of a tall variety of "Leaming" dent corn, which differ only in the environment to which they are exposed. Their ancestry is the same. In fact, the kernels with which both plots were planted came from the same ear. The difference in height between the tall plants on the left and the short plants on the right is due entirely to environment. The tall plants were planted far apart in hills, the short plants were crowded. Otherwise the conditions were similar. Crowding is obviously a bad environment which has dwarfed the plants. From another view point, abundant room for development may be considered a good environment which has stimulated the plants to unusual growth.

The differences between the two plots were more marked than one would judge from the photograph. At the edge of the crowded plot the effect of crowding was less intense and it is these plants on the edge which are seen and not the much smaller ones in the worse environment at the center. The crowding affected not only the height but also the reproductive organs. Except for the more favored plants on the margins which bore a few nubbins with scanty kernels, no ears were produced by the crowded plants. The tassels which bear the male organs were less

readily suppressed than the female ears. Crowding is a compound influence. Inability to obtain sufficient moisture or food constituents from the soil, an accumulation of poisonous excretions from the roots, the lack of sufficient light and air, may all be responsible in greater or less degree for the observed effect.

THE FORCE OF HEREDITY.

But while environment is a potent cause of variation, heredity is still more important. The diversity of a kitchen garden with its regular rows of beets, corn, beans, and cabbage, is primarily due to the different hereditary characters bound up in the different kinds of seed that were planted. A cabbage seed will grow into a cabbage and not into a corn plant merely because its ancestors were cabbages and not corn. Not only are the different species of plants distinct on account of heredity, but the different cultivated varieties as well. In figure 15 is shown a plant of the Tom Thumb variety of pop corn beside a plant of the Leaming dent corn.

The Tom Thumb variety was grown in hills under the same favorable garden conditions as the tall Leaming corn already seen at the left in Figure 13. The environment is practically the same for the two forms, and the small size of the pop corn is due to the fact that the seed they were grown from was produced by a small-sized variety. It is perhaps fruitless to debate whether in corn environment is the more important or heredity. The latter has brought about the difference in height between the tall Leaming and the dwarf pop corn. The former is responsible for the effects of crowding shown in Figure 13.

But heredity must not be considered as effective only in the broader groups known as species and varieties. Each variety is doubtless a complex of many mingled types which have not been separated. Thus several races have been isolated from the tall Leaming corn of Figure 13. Of two such races picked out by the Illinois Experiment Station, one forms high ears, the other low ears. Likewise, from the same tall variety there have been separated out races that differ in the storage products in the kernels; one with a high, another with a low, oil content; one with a large proportion of protein, another poor in protein. The plants of these races differ thus chemically because of hereditary differences in their parentage. Heredity as a factor in the diversity in living forms is always present. When environment is the same, heredity is the sole cause of variation. Usually both are effective.

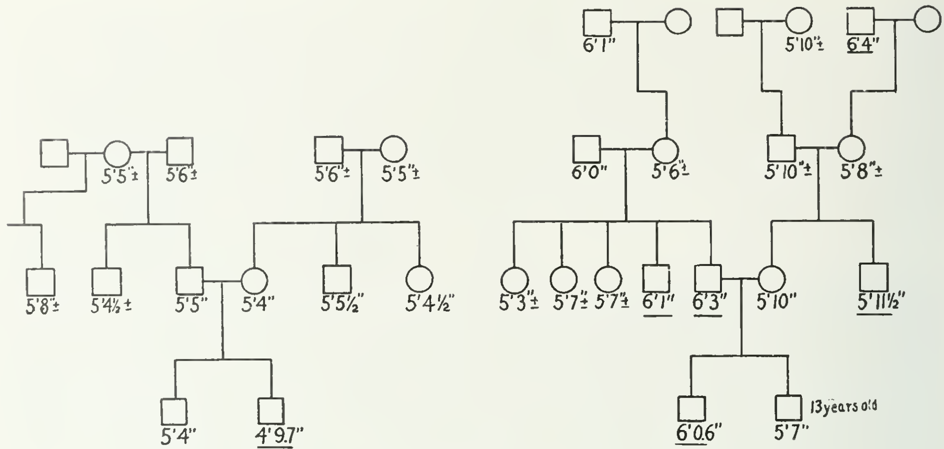
Let us return to the students shown in Figure 12 and see if we can discover which factor, heredity or environment, has been the more important in causing their differences in height. One from either extreme of the curve kindly consented to investigate the heights of his relatives with the results shown in Figure 14. The short student was 19 years old and the tall student was 17½. Squares indicate men and circles women, the figures underlined are stocking feet measurements. By estimating whether an uncle or a grandfather was shorter or taller than the father, a fair degree of accuracy was obtained of members of the family that could not be directly measured.

An inspection of the pedigrees shows that the small student comes from a short family. Except for a half uncle who was of about average height (5 ft. 8 in.), all his relatives of whom records could be obtained were undersized and none was over 5 ft. 6 in., which is about two inches below the average.

The tall student whose pedigree is given on the right has an entirely different ancestral history. Six footers run in both sides of the family. His great grandfather was reputed to be 6 ft. 4 in. in his stocking feet and the tallest and strongest man in his township. His brother, at present only 13 years old, is 5 ft. 7 in. and would now pass in his family as a relatively tall man had he been born into the other pedigree.

WHERE ENVIRONMENT ENTERS.

The data given confirm the more extensive evidence from other sources that heredity is the prime factor re-



WHY BOYS GROW SHORT OR TALL

Symbolical pedigrees of the two students shown at the ends of the line in fig. 12, and again shown in fig. 15. On the left, that of the shortest student (from the four feet, 10 inches rank); on the right, that of one of the tallest students (from the six ft., one in. rank). Squares represent men and circles women; figures underlined denote measurement in stocking feet. It is obvious from a comparison of the individuals in the ancestry of the two boys that the short student is short principally because his ancestors were short, while the tall one gains his height likewise from heredity. Bad environment might have stunted the latter; good environment could never had made the short student tall. (Fig. 14.)

sponsible for height differences in man. The cause is the same as that producing the tall Leaming dent and the short Tom Thumb pop varieties of corn. In illustration of this fact the students whose pedigrees have been given kindly consented to be photographed beside the appropriate variety of corn on either side of the nine foot pole shown in Figure 15.

It must not be assumed that environment has no influence at all upon man's stature. The question that the shorter student asked, if he was small because he had smoked since he was eight years old, was not entirely irrelevant despite the fact that the taller student had also used tobacco from his tenth year upward. Evidence shows that environment does have an effect upon man's physical as well as mental characteristics. Environment can influence the height of corn within certain limits. But the ancestry of the pop corn and of the student standing beside it foreordain both to a growth of limited proportions even under the best environment, while the Leaming corn and the boy of tall ancestry will both tend to grow tall despite a bad environment.

The facts that have been presented may appear familiar and the distinctions drawn trivial. But the distinctions lie at the base of all efforts for human betterment and are far from trivial in their significance. Although frequently confused by the similarity of their immediate effects, environment and heredity as causes are fundamentally different. Environment works upon the individual and its effects are transient. Heredity works upon the offspring and its effects are permanent, from generation to generation. Inherent characteristics only are transmitted. It has been generally assumed that characters acquired as a response to a good or to a bad environment are handed on to the next generation—that for example a man's college education will affect the mind of his newly-born children. Increasing knowledge has failed to support this assumption. "Acquired characters" seemingly cannot be handed on to one's descendants.

HEIGHT IN CORN AND MEN

Extremes in height from the array of students shown in fig. 12, photographed beside extreme varieties of corn which, like the students, owe their differences in height indisputably to heredity rather than to environment. No imaginable environmental influences could reverse the positions of these boys, or of these varieties of corn, the heredity in each case being what it is. Pedigrees of the two students are given in the preceding figure. (Fig. 15.)

In the past, environment has been assumed to be well nigh the sole cause of variation in the human race. The gratuitous pronouncement in the Declaration of Independence that all men are born equal has been accepted as literal inspiration. Recent discoveries of definite laws of inheritance have shown the dominant influence of heredity and the pendulum of opinion is swinging away from the side of environment. The enthusiasm, however, with which some would thoughtlessly rush into eugenics and eugenic legislation shows that they may stand in danger of having the new light blind their eyes to the influence of environment as a factor to be considered.

Man may be likened to the varieties of corn—good, bad and indifferent. The world around him, with opportunities, with education, may be compared to the garden plots of soil, also good, bad and indifferent.

In the garden of human life as in the garden of corn, success is the resultant complex of the two factors, environment and heredity.

NEW PUBLICATIONS

THE PROGRESS OF EUGENICS, by C. W. Saleeby, M. D. Pp. 253, price $1.50 net. Funk and Wagnalls Company, New York, 1914.

Few American eugenists are likely to define the scope of their science so broadly as does Dr. Saleeby, the active English propagandist whose earlier volume, Parenthood and Race Culture (1909), has led many readers to their first acquaintance with the ideals of race betterment. By including such problems as education and better housing for the poor, he opens questions whose importance no one will dispute, but which genetists in this country seem more and more inclined to leave in the hands of the avowed euthenist. To this extent, the content of Dr. Saleeby's book is likely to be slightly disappointing, while his acceptance of Lamarckian principles is certain also to call forth criticism. "The Progress of Eugenics" is an enthusiastic piece of special pleading, rather than a contribution to our knowledge of the science, but it is pretty certain to meet with a large and sympathetic audience, among whom it can hardly fail to be of real value in forwarding the interests of human genetics. Dr. Saleeby is rather pessimistic as to the immediate possibility of progress in the application of what he calls "positive eugenics," considering that "negative eugenics" must occupy most of the attention of the science for many years to come.

Children of the Tuberculous

Some of the effects of parental tuberculosis on the children are investigated by Dr. Wilhelm Weinberg, Sanitätsrat of Stuttgart, in his recently published book, "Die Kinder der Tuberkulosen," his material being several thousand families from the municipal statistics of Stuttgart. Dr. Weinberg, who is the principal exponent of the biometric method in German eugenics, asks and answers the following questions:

Is there, as is often believed, an excessive fecundity among the tuberculous? He finds the contrary to be the case, although the decrease is small.

Is there an unusually high death rate among children, one or both of whose parents died of tuberculosis? He finds that there is some increase, most of which is easily accounted for by infection and the fact that tuberculous stocks are frequently weak in other respects. He does not eliminate the influence of heredity but concludes that there is not yet a possibility of measuring its effect.

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Date of issue of this number, November 25, 1914.

A "SIAMESE TWIN" PIGWEED

Three plants like this were found growing in a back yard. Investigation shows that they are sectorial chimeras—plants made up of two kinds of tissue (green and white) which remain perfectly distinct, so that one may describe the pigweed as consisting of a white plant and a green plant, each forming part of the whole individual. A streak can be seen running down the main stem of the plant, composed of white tissue like that in the leaves. Many plants with variegated leaves have been studied in recent years, and their surprising manner of heredity explained, partly by mathematical formulas. (Frontispiece.)

PLANT CHIMERAS

Recent Spectacular Productions of Experimental Horticulture—Their Existence Known for Nearly Three Centuries—Only One of Them a True Graft Hybrid.

THE EDITOR

TWO plants of different species grown together so closely that one forms the whole outside like a glove and the other the inside like one's hand; or like Siamese twins, one species forming one side of every part of the plant and the other species the other side: such are plant chimeras, perhaps the most spectacular horticultural discoveries of recent years.

Not that such things were never known before. They were first reported nearly three centuries ago, and doubtless existed centuries earlier, but unnoticed. It was not until lately, however, that their production under experimental conditions, and the study of their cells under the microscope, made it possible for botanists to understand exactly what they were. Now that we know the trick, they can be produced by anyone with patience, and the mystery surrounding the so-called "graft hybrid," a bone of contention among horticulturists for several centuries, has vanished.

Broadly speaking, any plant produced by grafting one species on another is a graft hybrid. Such an operation has been practised since prehistoric times, and at present some plants are almost never grown on their own roots, as the saying is, but are grafted on some hardier stock. Thus the Washington Navel orange in California is regularly grown on some such stock as the pomelo, or the hardy and vigorous *Citrus trifoliata* of Japan; and the resulting trees are, in the broadest sense of the phrase, graft hybrids, being the union of two distinct species through grafting.

But under these conditions, each of the parent species maintains its separate life, as far as the cells are concerned. These only come in contact along the line where the graft was made; the roots remain just what they were—*Citrus trifoliata*, in the case chosen for illustration; the branches remain just what they were—*Citrus aurantium*, the navel orange. Each species exercises a slight influence on the one to which it is united, but in general they maintain their separate identity and their systems of cells come in contact, as was said, only at one plane in the whole plant.

We can go two steps farther in the production of graft hybrids, however. First, we can produce hybrids where the cell systems of the two parents are in contact throughout much or most of the plant; second, it appears that we can produce hybrids where the cells of the two parents actually blend. I shall leave the latter case for discussion further on, and explain in more detail the commoner cases where the two parents bear the relation to each other, in the hybrid, of Siamese twins, or glove to the hand it encases. A short account of the way in which the nature of these chimeras was discovered will perhaps be helpful.

HISTORY OF CHIMERAS.

The first one brought to the attention of men of science was a product of the genus Citrus, and has always been known as the Bizarria—because of its bizarre appearance, of course. It now exists in many forms, and new ones are appearing almost every year. One of the original type is shown in fig. 1 and a recent specimen which sprang into existence in Florida a few years ago is shown in fig. 3. The original Bizarria is said to have appeared in Florence,

THE FIRST RECORDED CHIMERA

The Bizarria, a citrus graft-hybrid which appeared in Florence, Italy, about 1644. Its origin was in a graft between a citron and an orange, and the exact nature of the freak was a matter of hot debate between botanists, which ended only a few years ago in the discoveries of Dr. Erwin Baur and the experiments of Dr. Hans Winkler. The fruit here shown about natural size is part orange and part citron. Photograph from the New York Botanical Garden. (Fig. 1.)

Italy, in the year 1644, where a gardener asserted that he had created it by uniting buds of several different trees. There seems reason to believe that as a fact "the first branch came from a callus at the base of the dead scion of a graft between the orange and the citron." The tree was propagated asexually, by budding or grafting, until it was spread all over Europe; it bore fruits which showed at various times the characters of almost any species of Citrus: orange, lemon, citron, lime. The leaves showed a similar variability. So did the flowers. The old botanists were astounded and confounded. The Bizarria became one of the stock topics of controversy, some claiming it for a graft hybrid, while others thought it could be nothing more than an ordinary sex-hybrid; that is, a hybrid produced by the common method of cross-pollination. But when fruits were brought in which were compounded, to all appearance, of four or five different species, or which were typical lemons on the outside and typical oranges inside, the acutest of the horticulturists had to content themselves with guesswork.

In 1825 another striking graft-hybrid was brought to public notice in the garden of M. Adam near Paris, where two closely related leguminous plants had been grafted together. The stock was the common laburnum of gardens (*Laburnum vulgare*, J. Presl.), on which was grafted a branch of *Cytisus purpureus* Scop., a kind of Scotch Broom. From this graft a branch arose that was somewhat intermediate between the two parents in character, and was propagated under the name of *Cytisus adami* Poit. Its behavior was so freakish that it not only brought poor Adam notoriety, but came near costing him his reputation, some of the greatest

botanists of the time feeling certain that his straightforward account of its origin must be a fairy tale. This particular graft hybrid showed itself, when propagated, to be inconstant in character, tending to revert to one of the parent forms, so it is not unusual to find a tree of *Cytisus adami* on some branches of which are borne the yellow blossoms of the laburnum, on others the purple blossoms of the broom, and on still others a mixed form showing the influence of both. In this case several eminent botanists insisted that the branch used by Adam in his original graft must have been taken from a sex-hybrid plant, a view that has not wholly been given up yet,[1] although hardly tenable in the light of our present knowledge of chimeras.

THE WHITETHORN MEDLAR.

The third classical example is that of the medlar (*Mespilus germanica*) near Metz, Germany, on which a branch of whitethorn (*Crataegus monogyna*) was grafted more than a century ago. From the graft there grew three sprouts which showed various blends of the characters of the two parents. The original tree, references to which abound in botanical literature, is still in existence; its hybrid shoots when propagated show a constant tendency to revert to one of the parent types.

These examples indicate how chimeras, or graft-hybrids of a pronounced type, originate unexpectedly. With the growth of the experimental method in botany came a realization that the only way to settle the problem of the origin of these freaks was to produce similar ones in the laboratory under controlled conditions. Dr. Hans Winkler, then at the University of Tubingen but now director of the State Institute of Botany at Hamburg, Germany, undertook the task with spectacular success.

For his material he selected the tomato (*Solanum lycopersicum* or, according to the latest American nomenclature, *Lycopersicon esculentum*) and the nightshade (*Solanum nigrum*). These species are closely enough related to be handled conveniently, and yet differ markedly enough in general appearance to be identified easily by comparison. He grafted them on each other, reciprocally, using the common cleft or saddle graft, and after the graft had "taken" he cut through the stem of the plant at the point of graft, in such a way that the surface exposed contained sections of both parents (see fig. 4, A. B. and C.). The wound healed over with the formation of a callus, and, as usual, sprouts or "adventive shoots" grew up from it. Some of these sprouts grew from the part of the surface containing tomato plant tissue, some from that part containing nightshade tissue,

CALLUS TISSUE

Cutting showing the formation of callus around the edges, gradually spreading inward until it covers the whole wound. At this stage the callus tissue is soft and translucent; later it hardens and from it arise roots, if the cutting is planted (as in this case) or shoots, if the cut is above ground. From such sprouts plant chimeras are obtained. Photograph enlarged eight diameters. (Fig. 2.)

[1] At the Fourth International Conference on Genetics in Paris, 1911, L. Blaringhem upheld the idea that it was a sex-hybrid showing mosaic inheritance.

PROBABLE CHIMERA OF RECENT ORIGIN

Grapefruit from Florida which has apparently thrown out a section of orange. Such freaks are fairly common in all kinds of citrous fruits, and are sometimes explained as sectorial bud sports or variations. Apparently this fruit is made partly of grapefruit tissue and partly of orange tissue. How did the orange tissue get there? If it was in the bud to start with, having survived from the graft, then this is a real sectorial chimera. But if part of the grapefruit tissue suddenly changed into orange tissue, then this is not a chimera, in the usual sense of the word, but merely a bud sport or variation. It has frequently been explained as such, although there is not sufficient evidence that grapefruit tissue really can turn into orange tissue, in that way. Granted that it does, the fruit might be considered a spontaneous chimera. (Fig. 3.)

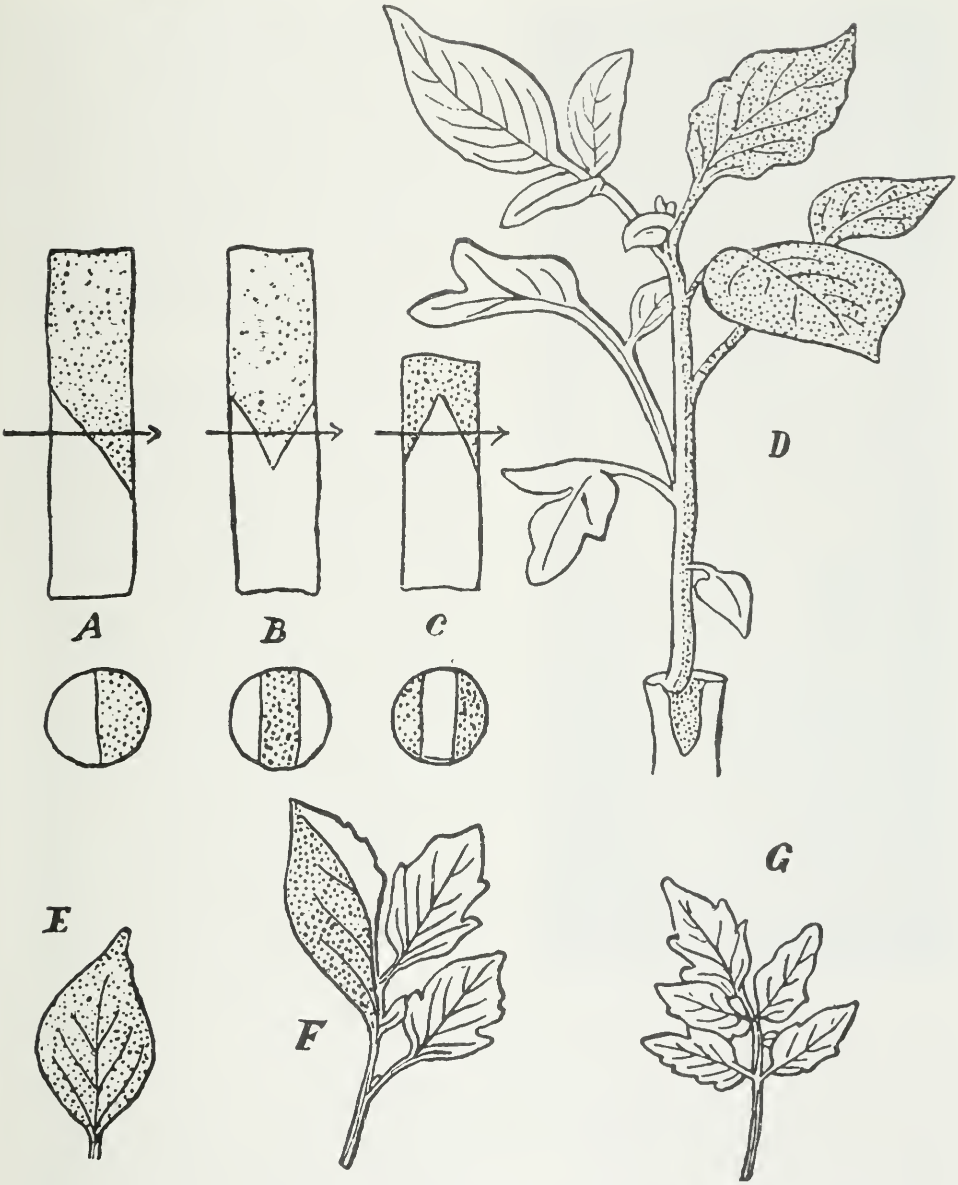
and some grew on the lines where these two kinds of tissue came together.

PRODUCTION OF BLEND.

The sprouts from tomato tissue produced tomato plants. The sprouts from nightshade tissue produced nightshade plants. But the sprouts which grew from points of union of the two kinds of tissue were neither the one nor the other; they were both! For the first time, graft-hybrids of this type had been experimentally produced.

In these first chimeras, the glove-and-hand relationship did not exist. The relationship was like that of the Siamese twins, the two plants existing side by side in the same stem and leaves, and yet retaining their identity. One side of the stem, with the leaves and flowers appertaining to it, was characteristically tomato, the other side was just as indisputably nightshade (see fig. 4, D.E.F. and G.). In a cross section of the main stem, each kind of tissue occupies a distinct segment or sector; these graft-hybrids, therefore, are known as *sectorial chimeras*.

This success did not satisfy Dr. Winkler, and he continued with his



HOW SECTORIAL CHIMERAS ARE MADE

A, B and C show three different forms of graft, the shaded area representing nightshade and the white area tomato. When cut through at the points indicated by the arrows, the stems present the appearance in cross-section of the circles underneath them. The cut surface forms a callus, a sort of scab, from which sprouts put forth; if one of them arises directly over the line of union of the two kinds of tissue, it will draw half of its substance from each, as shown in D, where the left-hand side of the plant is tomato and the right hand nightshade. For the purpose of comparison, a nightshade leaf is shown at E and a tomato leaf at G; a chimera-leaf made up of both plants is represented in F. After Winkler. (Fig. 4.)

experiments. In 1908 he at last succeeded in producing what he wanted—a graft-hybrid in which the union was not a mere partnership between species retaining each its own individuality, but in which the two actually blended into something new. After the number of attempts had run up into the hundreds, he finally observed a sprout "which when propagated produced plants having leaves, flowers and fruit which were different from those either of the tomato or of the nightshade. This new form was named *Solanum tubingense*. The general appearance of this type is intermediate between the tomato and the nightshade. The leaves are simple, sharply serrate and often lobed much like the leaflets of the tomato plant. The stems and leaves are hairy like the tomato. The corolla and the calyx are larger than those of the nightshade but smaller than those of the tomato. The fruit is slightly larger than the fruits of the nightshade, which are much smaller than the fruits of the variety of the tomato used in the graft. Many of the fruits of this type are sterile but several generations of seedlings grown from seed have been pure nightshade and are not like the plants *Solanum tubingense* from which they were derived.

"In continuing his experiments Dr. Winkler soon obtained the three other types of tomato-nightshade chimeras shown in the plate illustrating this article. *Solanum gaertnerianum* resembles the nightshade more than the tomato. The leaves are less entire than those of the nightshade. The flowers are greenish in color and are dwarfed, the petals remaining rudimentary. This form fruits sparsely but some seeds are perfectly developed and produce pure nightshade plants.

"In general shape the leaves of the form *Solanum koelreuterianum* resemble strongly the tomato, but the epidermis is free of hairs like the nightshade. The flowers are white with yellow middle streaks. The fruit does not mature. This particular type has appeared several different times.

"The form called *Solanum proteus* also resembles the tomato more than the nightshade, although not to the extent of leaf shape seen in *S. koelreuterianum*. The stems and leaves are hairy. The fruits produced are smaller than those of the tomato, but resemble them in form."[2]

THE CHIMERAS EXPLAINED.

Winkler's success now seemed complete: he had produced four plants that in appearance were genuine graft-hybrids in which the two parents were wholly blended. The exact nature of his success had not yet been explained, however, and this explanation remained for another German, Dr. Erwin Baur of Berlin, who had been studying with a microscope the cells in the leaves of that very common perennial, the variegated geranium (*Pelargonium zonale*). Everyone knew that some geraniums bear partly green leaves and partly white ones, and that there are well-fixed commercial varieties which regularly bear green leaves with white edges. Baur wanted to know why this happened, so he began to raise sectorial chimeras, made up of green geranium and white geranium. It will be remembered that, in favorable cases, these two kinds of tissue exist side by side all the way up the stem and in the terminal bud.

Now suppose that in this terminal bud, where the two kinds of cells are side by side, the white cells at the surface begin to grow a bit faster than the neighboring green cells, so that they crowd over a little way into the green territory. Then we have part of the

[2] Stout, A. B. Plant Chimeras. Journal of N. Y. Botanical Garden, XIV, 164, pp. 145-150, August, 1913. Winkler last year sent rooted specimens of these four chimeras to the New York garden, where they have been propagated and distributed to several institutions in the United States. In a letter dated Oct. 7, Dr. Stout says: "During the past summer, the chimeras have done poorly, and do not seem to reproduce readily through cuttings, although we have made extra efforts to secure most favorable conditions for them. One of the chimeras, gaertnerianum, has died out completely. I find that tubingense and koelreuterianum are the only ones that are inclined to make big, bushy plants. I saw Winkler's chimeras at Hamburg during the past summer. None of them were big, lusty plants. He propagates from terminal and sides branches, getting young and rather small plants. I have secured the pure tomato and pure nightshade seeds of chimeras and they grow very well."

green tissue in the terminal bud overlaid by a layer or two of white cells. Now if a branch starts out just at this point where the green cells have been overlaid by white, it will start from and with green tissue, but it will have to make its way through this skin of white cells, and will take them along with it as its own outer tissue. As the branch grows, the white cells grow along with it on its surface, still retaining their connection with their parent white tissue, while the larger part of the branch—namely, all the interior part—is made of the green tissue. So when the branch finally attains its full size it might be described, figuratively, as consisting of a white branch and leaves, hollow, into which a green branch and leaves of the same shape but a little smaller have been thrust up. In other words, it is a hand in a glove. Most of each leaf appears green, because the thin layer of white cells is underlaid by so much green tissue that shows through; but at the edges of the leaves the green cells were crowded back, the white cells hold undisputed possession, and no green is to be seen, the result being the white edge around the periphery of the leaf. Because of this peripheral distribution of the white cells, Baur called such chimeras *periclinal*, to distinguish them from the sectorial chimeras which both he and Winkler had produced in the earlier stages of their experiments.

THE SOLANUM CHIMERAS.

It was at once suggested that Winkler's later chimeras—those of the blended or intermediate type, which he himself had never been able satisfactorily to explain—were periclinal chimeras. He made a careful examination of them on this hypothesis, and reported that such was the fact. In *Solanum tubingense* and *S. proteus*, he found that the entire body of the plant, consisting of nightshade, was overlaid by a film of tomato tissue, in the former case consisting of only one layer of tomato cells, and in the latter case of two. *Solanum gaertnerianum* and *S. koelreuterianum* were found to be tomato at heart, but wholly clad in a skin of nightshade, the

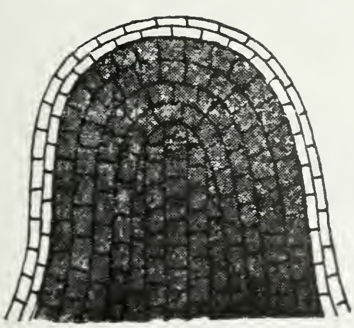
SIMPLE GRAFT

This illustrates the simplest form of graft—a split, cleft or wedge graft. Of the two plants thus united, the lower one, which furnishes the root system, is called the stock; the upper one, which furnishes the branches of the developed plant; is known as the scion. When the scion is inserted in the stock, as, here shown, and the graft bound up, callus tissue forms at all the points of juncture. To produce chimeras the whole graft, after it has "taken," is cut in two along the line shown, so that the cut surface on top includes parts of both stock and scion; more callus forms on this top plane and gives rise to sprouts which, in favorable cases, show the characters of both parents. Enlarged eight diameters. (Fig. 5.)

WINKLER'S SOLANUM CHIMERAS

These plants were produced by grafting tomato on nightshade (and vice versa) and then decapitating the graft, cutting through the points of contact between scion and stock. From left to right, the plants are *Solanum gaertnerianum*, *S. koelreuterianum*, *S. proteus* and *S. tubingense*. As will be seen, the first one resembles the nightshade more than the tomato parent, the second inclines more to the tomato, the third is somewhat similar, while the fourth again resembles the nightshade. The last two have a nightshade body covered with tomato cells, the first two have a tomato body covered with nightshade cells. Such freaks are called periclinal chimeras. Photograph from the New York Botanical Garden. (Fig. 6.)

1.



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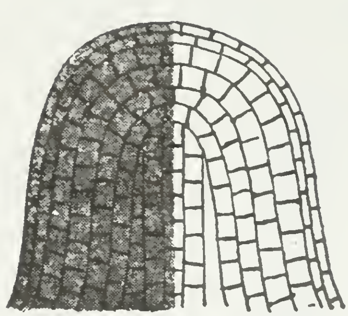


TWO FORMS OF CHIMERAS

Diagram after Baur showing the difference between sectorial and periclinal chimeras, as exhibited in the terminal bud. The bud at the left (No. 1) may be taken to represent a periclinal chimera between a white plant and a green plant; the green tissue is entirely overlaid with a layer of white cells, so that any branch sent out from the green tissue must of necessity pass through and carry with it white cells as an outer skin. At the right (No. 2) is the bud of a sectorial chimera between white and green plants, where the two kinds of tissue exist side by side and come in contact only in one plane. Obviously, any branch sent out from the green tissue will be green, any branch sent out from the white side will be white. It is only a branch arising exactly on the line of juncture of the two kinds of tissue that may be expected to carry both kinds of cells and thus form a sectorial chimera. (Fig. 7.)

latter sort of cells being two layers deep in *S. gaertnerianum*, while *S. koelreuterianum* had but one layer.

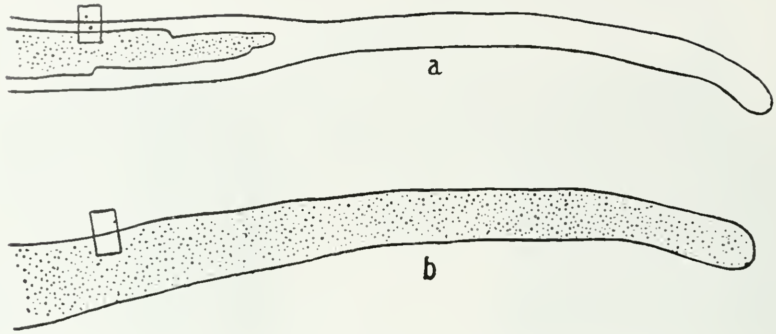
As soon as it was understood what this kind of graft-hybridization really meant, attention at once reverted, of course, to the classic specimens. *Cytisus adami* was found to be a laburnum in disguise, so to speak—a laburnum with the skin of a purple broom. Baur demonstrated that the Crataego-mespilus was also a periclinal chimera, its epidermis being derived from the medlar and its interior from the whitethorn. By common consent, the Bizarria was separated from these and put in the class of sectorial chimeras.

Since then many other chimeras, belonging to one or other of these two classes, have been produced, or have been found in nature, particularly in such variegated plants as Coleus.[3] One of the most recent was produced by grafting a peach on an almond. The first crop borne consisted of true peaches, but in the next year the tree produced buds some of which resembled those of an almond, while others were like peach buds and others again were intermediate. Seeds from the graft produced trees which in foliage resembled both the parents. An apparent chimera made of two varieties of rhododendron was produced by grafting Madame Linden on Cunningham's White. "A shoot which had been left on the stock just below the graft produced pale rosy-lilac flowers; whereas the flowers of the stock are white, and those of the scion deep rosy-lilac with dark red spots. The form of leaf borne by the anomalous shoot is also distinct, approaching that of the scion."[4] If more horticulturists would make the attempt, it is probable that the number of chimeras reported would be very large. Winkler has pointed out[5] num-

[3] See also Castle, W. E. An Apple Chimera. JOURNAL OF HEREDITY, V, 5, pp. 200-202, Washington, May, 1914.

[4] Revue Horticole, Paris, August 1, 1913, and September 1, 1913; abstract in Gardeners Chronicle, London, May 16, 1914.

[5] Die Chimärenforschung als Methode der experimentellen Biologie, in Sitzungsberichten der phys.-med. Ges. zu Würzburg, 1913. For the original reports of his work, see Winkler, Hans. Ueber Pfropfbastarde u. pflanzliche Chimären, Ber. d. deutsch. Botan. Ges., 25, 568, 1907; same author, *Solanum Tubingense*, ein echter Pfropfbastard zwischen Tomate u. Nachtschatten, ibid., 26, 595, 1908; and the same journal, *passim*, during those and the following years, for the views of the leading German botanists on the whole subject. The files of the Gardeners' Chronicle (London) may also be consulted with profit by those interested in graft-hybrids.



LIKE A FINGER IN A GLOVE

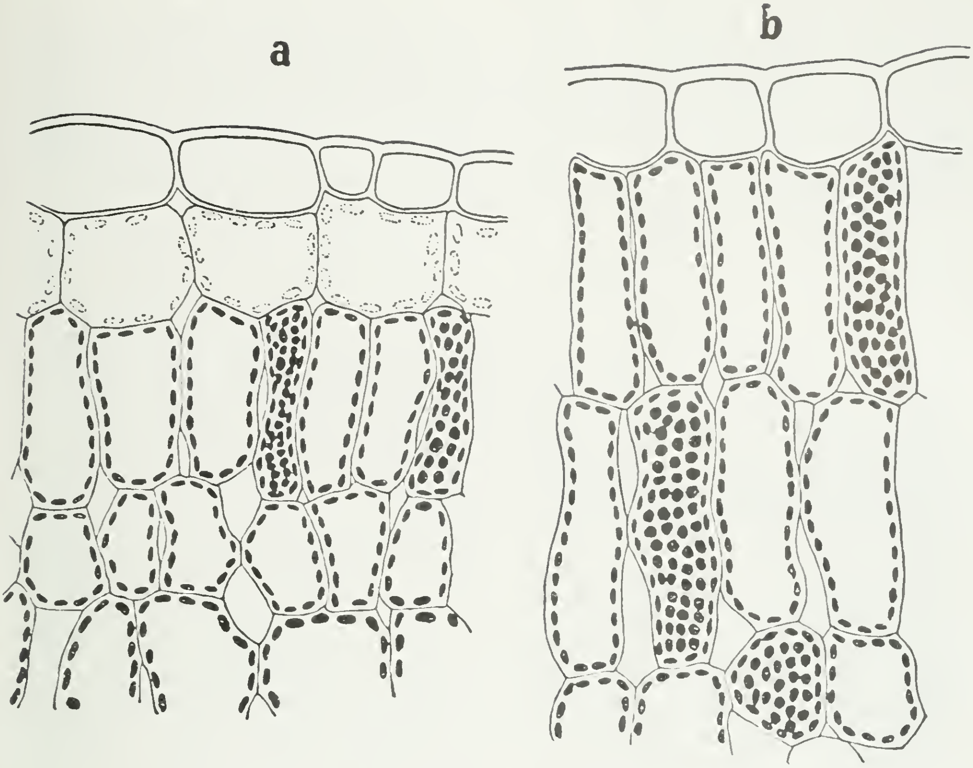
Diagram of edges of two geranium leaves in cross-section, after Baur. (a) is that of a variegated geranium; the outer part is white, but inside there is a mass of green tissue, entirely overlaid by white. (b) is a normal green leaved geranium, no white cells being present. The section enclosed in the small rectangle in each one is shown enlarged in Fig. 9, the following illustration. (Fig. 8.)

erous ways in which experiments with them may yield commercial results, as well as throw light on problems of plant physiology and heredity, and the study of chimeras is probably destined to become a regular part of experimental horticulture. It is not always easy, however: Winkler made 268 grafts, which resulted in the production of more than 3000 sprouts, in order to get the five chimeras which stand to his credit.

THE TEST OF BREEDING.

Discovery of the nature of these chimeras was made possible only by the association of the microscope with genetics, for mere observation of their behavior when propagated would hardly have cleared up the mystery. If they are to be considered really hybrids, they ought theoretically to represent the hybrid generation (F_1) in spite of the fact that they were produced by grafts rather than seeds. Their own seedlings should then represent the critical second filial (F_2) generation, and either show a new type that bred true (a behavior that, in hybrids of distinct species, would occasion no great surprise) or else split up into a variety of forms, as most hybrids do in that generation. It has already been mentioned that the seedlings of *Solanum tubingense* were nothing more nor less than little nightshades, which bred true in all succeeding generations. Similar results were found with the other three chimeras, each one breeding true to the parent which it most resembled.

Another suggested test was to compare them with the normal sex-hybrids produced by cross-pollinating the tomato and nightshade. This could not be done, however, because the investigators were not able successfully to cross those two species. There was one line of attack left—namely, a study of the cell contents. Those who possess an elementary knowledge of biology know that each cell has a nucleus containing certain little rods of easily-stained material called chromosomes, that the number of chromosomes varies from species to species, but that within each species it is constant. This, therefore, gave a means of identifying either one of the parents found in the sectorial chimeras. The tomato possesses 24 chromosomes, the nightshade 72. In a real hybrid, the number of chromosomes would, by expectation, be the sum of half of each of these numbers, that is, $12+36=48$. On the other hand, as this hybrid was created by vegetative means, the reduction to one-half the normal number, which occurs in the chromosomes in sexual conjugation, might conceivably not take place; if it did not, the sectorial chimeras would be expected to possess $24+72=96$ chromosomes. So the microscope was brought out, and the chromosomes of



HOW THE GREEN CELLS ARE OVERLAID BY WHITE

Highly magnified cross section of parts of geranium leaves, after Baur. At the top of each one is seen a colorless layer of cells forming the epidermis, and common to all geraniums. (a) represents a variegated geranium; below the epidermis is seen a single layer of almost colorless cells which come from a white plant. They are found not only at the surface of this leaf, but of all the other leaves and stems of the plant. Below this layer of white cells is the mass of green cells, bearing chlorophyll granules, which make up the body of this variegated plant. (b) shows part of the leaf of an ordinary green geranium. There are no white cells, the whole plant being made up of green tissue. The essence of a chimera is that it be composed of tissues from two different plants. (Fig. 9.)

pollen grains and ovules from all the new Solanums eagerly counted, with the expectation or at least the hope that the number found would be either 48 or 96. But the only counts secured were either 24 or 72; each chimera possessed the chromosome count of the parent which it most resembled, just as it reproduced that parent by seed.

ARE THE CHIMERAS HYBRIDS?

In the face of such results, the Solanums which Winkler had created with so much difficulty could hardly have ranked as hybrids of any kind, had not Baur's work showed the ingenious and unexpected way in which the two parents actually entered into the progeny, by the hand-in-glove method. As far as the evidence from breeding and from chromosome counts went, they would have had to be thrown out of the hybrid class; and this perhaps is the proper course after all, in spite of the fact that they are undeniable graft-hybrids, in the broadest sense of the term. If they are merely designated as chimeras, the term hybrid can be reserved for plants which more completely share the germplasm of their parents, and confusion will thereby be obviated.

But there is one more chimera, which was alluded to near the beginning of this paper and has since, for the sake of

simplicity, been studiously ignored. This, the fifth chimera secured by Winkler, and called by him, *Solanum darwinianum*, is in a different class from its predecessors. It appears to be a real graft-hybrid: indeed, it claims to be the only genuine, out-and-out graft-hybrid in the world.

In order to make this claim, it will be understood from what was just said that the chimera must show evidence of actual vegetative cell-fusion. It will not do to have the parents living side by side, as in a sectorial chimera, or even one enveloping the other, as in the periclinal chimera. They must actually unite, not only in body but particularly in germ-plasm. In *Solanum darwinianum* the tomato and nightshade seem at last to have reached that stage of union.

A count of the chromosomes shows their number to be 48. The evidence, therefore, indicates on its face that the cells (or at least some of the cells) of the two parents have here actually combined, each previously throwing out half of its chromosomes, as in normal sexual cell-conjugation. Just how this may have taken place is not yet entirely explicable, but if it has happened, *Solanum darwinianum* will have a strong claim to be considered a real graft-hybrid, the first one ever known.

To the old botanists, the existence of supposed graft-hybrids seems at times to have been rather resented—they interfered so much with theories about heredity! Fortunately we have passed that stage. "It is not too soon to say," as Goldschmidt[6] concludes, "that the idea that production of hybrids by vegetative propagation would upset all our fundamental ideas of the laws of heredity is to be considered absolutely groundless." There are still some problems to be solved, but we are not afraid that chimeras will complicate them. "On the contrary, the periclinal chimeras, and still more the sectorial chimeras, have introduced some extraordinarily important ideas in the solution of all kinds of genetic, morphological and physiological problems."

[6] Goldschmidt, Richard. Einführung in die Vererbungswissenschaft, p. 400. Leipzig und Berlin, 1913.

Essentials of a Free Society

Our present natural dispositions make it impossible for us to attain the ideal standard of a nation of men all judging soberly for themselves, and therefore the slavishness of the mass of our countrymen, in morals and intellect, must be an admitted fact in all schemes of regenerative policy.

The hereditary taint due to the primeval barbarism of our race, and maintained by later influences, will have to be bred out of it before our descendants can rise to the position of free members of an intelligent society; and I may add that the most likely nest at the present time, for self-reliant natures, is to be found in states founded and maintained by emigrants.—Francis Galton: Inquiries into Human Faculty (1907).

Photographs of Large Trees Wanted

In order to secure data of value to forestry, two members of the American Genetic Association have offered $100 each, for prizes to be awarded by this association for photographs of the largest native trees. Contestants are required to send in two photographs of each tree, one showing the entire tree and the other only the trunk. A prize of $100 will be given for the largest nut-bearing tree and another prize of the same size for the largest forest or shade tree, non-nut-bearing. The competition is not limited to members of this association, but photographs must be taken by or under the direction of the competitor. Conifers will not be considered. As much information as possible must be furnished about the tree which is photographed. Details regarding the contest were published in the JOURNAL OF HEREDITY for October, 1914 (Vol. V, No. 10), or may be secured by addressing the editor of the JOURNAL.

HEREDITY IN CHIMERAS

Pigweed with Variegated Leaves Proves to Be Sectorial Chimera—Variegated Plants Probably Produced by Mating of Green and White Gametes—Review of Present State of Knowledge of Chlorophyll Inheritance.

DR. WILLIAM S. CHAPIN, *Vanderbilt, Mich.*

IN AUGUST, 1912, I found three variegated-leaved pigweeds, *Amaranthus retroflexus*, growing within a yard of each other in a neglected corner of an old garden. I removed the healthiest plant to a large flower-pot in the house, where it started to blossom a week later. Beyond keeping it in the window, I made no effort to protect it from wind-borne pollen from outdoors.

The peculiar thing about these three pigweeds was their leaves, many of which had irregular patches of white where the chloroplasts had failed to develop. A few leaves were pure white while those on the other side of the stem were pure green. The white tissue, not being able to elaborate carbohydrates for itself, had to depend for food on that brought to it from the green portions of the plant. Consequently the white patches showed less growth than the rest of the leaf and this often caused the leaves to bend or curl toward the white areas. Such variegated plants are handicapped in the "Struggle for Existence" when in competition with green plants which have no parasitic white tissue to support and, if they have a large proportion of white tissue, are delicate and hard to raise.

The side branches also bore the character of the leaves from whose axils they sprung: e. g., pure green branches came from the axils of pure green leaves, pure white branches from the axils of pure white leaves, while from the axils of variegated leaves there might appear pure white, pure green or variegated branches depending on circumstances. It is believed that in such plants the apical cone, or mass of embryonic cells at the tip of the stem, is composed of two kinds of cells, some of which are able to produce green tissue while the others can only produce white. If all the white tissue embryonic cells happen to be bunched together on one side of the apical cone, the leaves formed from these cells alone will be pure white, while leaves on the other side of the stem formed only from green tissue embryonic cells will be pure green. Leaves formed from both sorts of cells are variegated and their pattern depends on the relative number and position of the green and white cells.

VARIATION IN THE LEAVES.

If the white and green embryonic cells always maintained their relative numbers and position in the apical cone, then theoretically each leaf on a stem might have the same pattern as the leaf directly below it. There is in fact a very strong resemblance between such leaves, but there is always some inequality in the growth of the cells of the apical cone with a consequent change in the pattern of the leaves. In some cases the green embryonic cells crowd the white ones entirely out of the apical cone or vice versa and the rest of the stem and leaves becomes pure green or pure white as the case may be. Such branches have never again become variegated so far as I have observed. In many variegated-leaved plants the white embryonic cells form a layer over the green ones in the apical cone. The leaves in such cases are a lighter green with white edges, the green cells being sandwiched in, so to speak, between an upper

and a lower layer of white cells. An illustration of this is to be seen in the variegated-leaved geraniums which are familiar to everyone. This type of variegation has never as yet appeared in the offspring of my pigweed.

About half of the seeds of the transplanted pigweed were planted in sterile soil in the spring of 1913. A few seeds from all green branches were saved separately. The results are given in Table 1.

TABLE 1. VARIEGATED PIGWEED 1.

Seedlings	Mixed seed No.	Mixed seed %	Seed from green branches No.	Seed from green branches %
Green plants	419	74	201	98
Variegated plants	11	2	0	0
White plants	134	24	4	2
Total	564	100	205	100

The contrast between the seedlings from the whole plant and those from the green branches alone seemed to be too great to be due to chance so the experiment was repeated by saving the three most vigorous variegated seedlings which were called 1A, 1B, 1C. Each plant was placed in a separate box of earth and protected from outside pollen as far as possible by a cage with a glass top and two layers of heavy muslin on the sides.

An all green slip from 1A was rooted in the house and its seed saved separately. As it was impossible to raise a pure white seedling or an all white slip, I saved some seeds by hand from a pure white branch on 1A. In the other two pigweeds the white and green tissues were so mixed that it was difficult to save seeds from the white tissue alone without including some from the green portions of the plant. The white tissue was also in much smaller amount in these plants than on plant 1A which probably accounts for the smaller proportion of white seedlings which they produced. A few seeds from the green branches of 1A were also saved by hand and most of them planted soon after they were gathered. To my great surprise not a seed came up and after standing around for several months, the box met with an accident and the seeds were lost. This showed that the seeds would have to mature before they would germinate so I waited until this spring before planting the rest of the seeds. The results are given in tables 2 and 3.

TABLE 2. VARIEGATED PIGWEED 1A.

Seedlings	Mixed seed from whole plant No.	%	Seed from 1A green slip No.	%	Seed from green branches 38 seeds No.	%	Seeds from white branches 165 seeds No.	%
Green	2605	62.3	1243	100	32	97.0	4	2.4
Variegated	38	0.9	0	0	0	0.0	0	0.0
White	1541	36.8	0	0	1	3.0	161	97.6
Total	4184	100.	1243	100.	33	100.	165	100.

Note. The four green seedlings in the right-hand column from seed taken from white branches come probably from wild seeds which were not killed in sterilization of the earth. The earth in this case was boiled for half an hour with occasional stirring in an open pan. In all other cases the earth was baked in a hot oven for at least three hours and then washed with three or four changes of water to remove any injurious substances which might be formed by the heat. That the earth in this box was insufficiently sterilized is shown by the fact that two other weeds, *Malva rotundifolia*, also appeared in this box. All the other boxes remained free from foreign weeds.

TABLE 3. VARIEGATED PIGWEEDS 1B AND 1C.

Seedlings	1B Mixed seed No.	1B Mixed seed %	1C Mixed seed No.	1C Mixed seed %
Green	2996	91.5	2413	91.6
Variegated	7	0.2	10	0.4
White	272	8.3	211	8.0
Total	3275	100.	2634	100.

Fifty-seven green seedlings of the original pigweed 1 were raised until they had five or more leaves. None of them showed the least variegation with white tissue, however. Twenty of these plants were placed together in a box where there was abundant opportunity for cross as well as self pollination. No attempt was made to avoid foreign pollen as this would come from green plants anyway and would not be likely to prevent the formation of white or variegated plants, if such could occur. As a matter of fact there were no wild pigweeds growing within a hundred feet of them. From the mixed seed of these plants a large sample was planted and I obtained 3492 seedlings, which were all green, none variegated or white.

From this it would appear in the case of these pigweeds that green tissue produces only green plants and white tissue only white plants when fertilization takes place between germ cells which come from the same tissue. Variegated plants are most likely formed from a cross between germ cells which come one from green and the other from white tissue. I have experiments planned for the future to determine this point, which will be the subject of another paper.

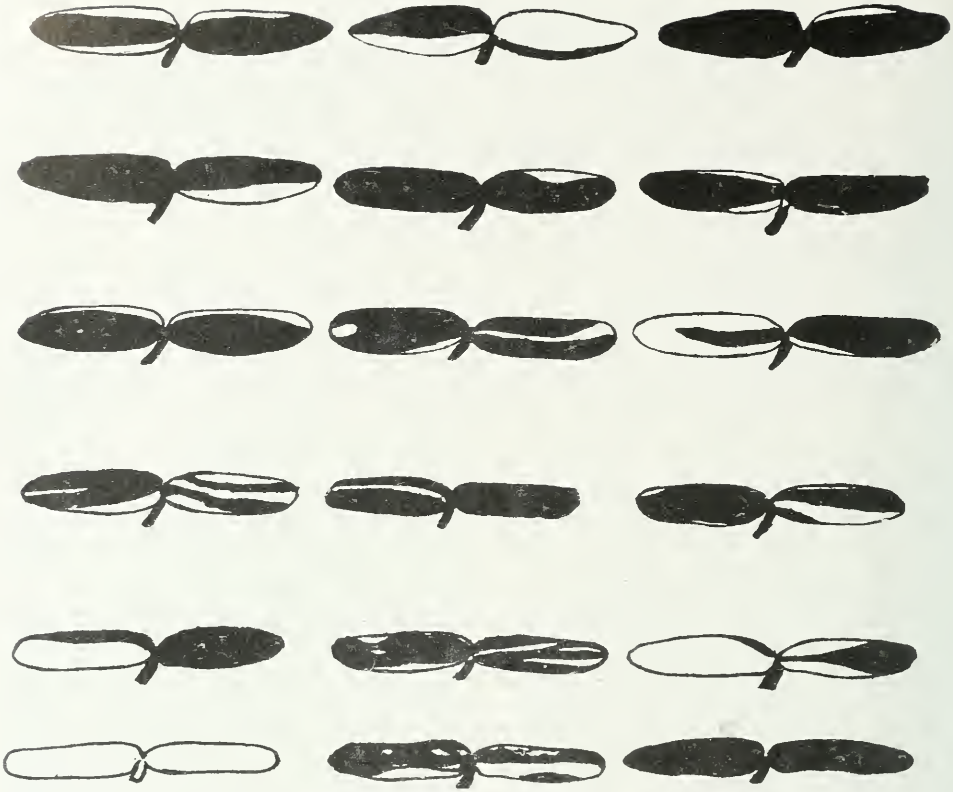
A word should be said as to the accuracy of these figures. I believe that they are essentially correct. The white seedlings always wither before the new leaves appear and if a way could be found to raise them some might prove to be variegated. This seems unlikely, however. A more important source of error consists in overlooking variegated plants which have only a little white in their cotyledons and counting them as green. I doubt if this error would amount to half of one per cent at the most.

The important thing is that we have here a race of plants with different hereditary characteristics on different branches. They are in fact natural chimeras, in distinction to those chimeras which are formed by grafting. If we could graft the white plants on green plants we might expect to get just such sorts of variegated individuals from adventitious shoots which included tissue from both stock and scion.

Baur (4) has reported a very similar condition among geraniums, *Pelargonium zonale*, which have white-edged leaves. The whole subject is so interesting from a genetic standpoint that I shall attempt a review of the main features of chlorophyll inheritance, and the hypotheses put forward to explain them. Besides the cases which I have given in this review others have been reported which do not seem to belong to any of these types. H. Molisch (13), for instance, has reported cabbages which develop variegated leaves on the approach of cold weather. The leaves become green again if the temperature is raised. The plants are true to seed, but no crosses with green plants were reported. Shull (16) also reports some very interesting variegations in the leaves of Melandrium.

CLASSIFICATION OF CHLOROPHYLL INHERITANCE.

1. Infectious Chlorosis. Not inherited. Transmitted only by grafting.
2. Mendelian Types of Inheritance.
   (a) Chlorophyll albinos. Forms which lack chlorophyll entirely. Known only as seedlings which soon die.
   (b) "Chlorina" and "Pallida" types. Leaves have less chlorophyll than normal. Leaf color fairly uniform.
3. Atypical Mendelian Types. Represented by the "Variegata" form of *Mirabilis jalapa*—Correns (10).
4. Non-Mendelian Types.
   (a) "Albomaculata" type. Variegated leaves. Inheritance through the mother. No segregation in the F_2 generation.
   (b) Sectorial and periclinal chimeras.



VARIATION IN PIGWEED CHIMERA SEEDLINGS

Seeds of the green and white pigweed chimera as shown in the frontispiece were planted and produced about three-fourths green and one-fourth white plants. A few of the plants were variegated, and it is believed that these were produced by the union of germ cells from green tissue and germ cells from white tissue. The patterns of the cotyledons of these variegated seedlings are shown in the above diagram, a pure white and pure green plant being sketched in the lower corners, for comparison. The heredity of these seedlings does not follow any mathematical law for the plants as a whole, but the relative number of white and green seedlings produced by a chimera depends largely on the ratio of white to green tissue. (Fig. 10.)

INFECTIOUS CHLOROSIS.

Under this heading Baur (1 and 2) describes a peculiar disease among Abutilons and other plants in which the leaves are green with white spots. The disease may be transferred to healthy green leaved plants by grafting, but in no other way. Healthy plants are not infected by contact with spotted plants even when grown together in the same pot. Baur was also unable to infect healthy plants by injecting them with tissue juices of chlorotic individuals and for this reason he believes that it is not a germ disease, although its ability to spread from plant to plant by grafting would lead one to suppose so. It seems to me possible, however, that the disease is due to an organism which lives in the vascular ducts and is so delicate that it is killed by the cell juices when the tissues are crushed. Infectious chlorosis is not inherited. Seedlings from infected plants are all green and normal.

CHLOROPHYLL ALBINOS.

The Mendelizing forms which lack chlorophyll entirely cannot be used in crosses because of their early death. We know of their existence only through the behavior of green or yellowish-green

A GERANIUM CHIMERA

Variegated geranium (*Pelargonium zonale*), the product of artificial cross-pollination. Its father had white-edged leaves like that shown in the lower left-hand corner, its mother had normal green leaves. The same cross produced plants which were apparently pure green and others which were apparently pure white, in addition to variegated plants of the type here shown. One of the upper branches of this geranium, it will be noted, is composed entirely of white tissue and so has only white leaves, while the lower branch is composed of green tissue which is partly enclosed on the left side with a thin layer of white cells. (Fig. 11.)

A CABBAGE CHIMERA

Variegated cabbage, whose heredity has not yet been put to the test of breeding. Dr. Chapin thinks it is probably a chimera showing both sectorial and periclinal variegation. (Fig. 12.)

plants which act as heterozygotes; that is, they produce green seedlings and white seedlings in the ratio of 3 : 1. Such plants have been reported by Baur (6) for Antirrhinum (Snapdragons) and Melandrium. Johannsen has also briefly reported a similar case in Phaseolus (Kidney Beans). Shull (16) has confirmed Baur's work with Melandrium.

Baur's Melandrium (6) is especially interesting. He found a wild *Melandrium album* which had one branch with a streak of white tissue on it affecting the leaves on that side. Eventually the white tissue surrounded the green, forming a periclinal chimera with white-edged leaves. A female blossom on this branch was then fertilized with pollen from a normal green plant. This was equivalent to a cross between white female and green male since the germ cells are only formed from the outer layer of cells just beneath the epidermis in the apical cone. This cross resulted in over 200 seedlings all green though a little paler than normal. When crossed with each other they produced green and white offspring in the ratio of 3 : 1. No variegated plants were produced. The question then was whether the white branch had sprung from a normal green plant or from a heterozygote for white and green. As self fertilization was impossible, flowers on the green branches were crossed with pollen from heterozygotic offspring of the white branch, produced as described, with the result that green and white seedlings were produced in the ratio of 3 : 1. If the plant had been a normal green homozygote such a cross would have produced only green plants.

Some of the earliest work on chlorophyll color was done by Baur (3) with an "aurea" form of snapdragon, *Antirrhinum majus*. The leaves of the "aurea" plants were yellowish green or golden in color and they had less chlorophyll than normal, green plants. Baur's experiments showed that the "aurea" plants were to be regarded as heterozygotes, for when self fertilized they produced green, "aurea" and yellow seedlings in the ratio of 1 : 2 : 1. The yellow seedlings soon died, as they had no chlorophyll in their leaves, but only a yellow pigment, carotin, which gave them their color. The cross between green plants and "aurea" plants gave green and "aurea" offspring in equal numbers. Evidently this case is like that of the famous Andalusian fowl.

"CHLORINA" AND "PALLIDA" TYPES.

Plants which have less than the normal amount of chlorophyll in their leaves, are true to seed and behave as typical recessives when crossed with normal green plants, have been described by Baur, Correns, Shull and others. "Chlorina" forms have been described by Baur (5, 6) for *Antirrhinum majus* (Snapdragon) and *Aquilegia vulgaris;* by Correns (9, 10) for *Mirabilis jalapa* (Four O'Clocks) and *Urtica pilulifera* and *U. dodarti* and by Shull (16) for *Melandrium*. The "pallida" type has only been reported by Shull for Melandrium. Price and Drinkard (15) report a case of yellow leaved tomatoes which appears to belong in this class.

Correns' "chlorina" type of *Mirabilis jalapa* has pale green leaves which contain 28 to 30% of chlorophyll. The plants and their flowers are smaller than usual on this account. The color seems to be fairly uniform, though it varies somewhat in different plants. In Melandrium Shull says the "chlorina" plants have about 43% of chlorophyll in their leaves. The color varies considerably in intensity in different plants and even in different parts of the same plant. They also have a tendency to bleach in strong sunlight, especially near their centers. The "pallida" type of Melandrium differs from "chlorina" in having rather darker leaves (about 65% chlorophyll) which do not fade in sunlight. The color is more uniform than in "chlorina."

THE MENDELIAN EXPLANATION.

If we let X represent the sum of all the unknown factors for chlorophyll color, then the following formulas will explain Shull's results with Melandrium.

1. XX ZZ YY NN produces normal, green leaves.
2. XX zz YY NN forms a white plant without chorophyll which soon dies because it lacks the Z factor.
3. XX Zz YY NN is green like no. 1 but differs in being a heterozygote. Its offspring are green plants and white plants in the ratio of 3 : 1.
4. XX ZZ yy NN gives the "pallida" form.
5. XX ZZ Yy NN represents the hybrid between green and "pallida." It has green leaves and produces green and "pallida" offspring in the ratio of 3 : 1.
6. XX ZZ YY nn gives the "chlorina" form. Like "pallida" it behaves as a simple recessive to normal green. The cross between "chlorina" (XX ZZ YY nn) and "pallida" (XX ZZ yy NN) produces a green leaved plant with the formula:
7. XX ZZ Yy Nn whose offspring in the F_2 generation are composed of green, "chlorina" and "pallida" plants. Theoretically the ratio should be 9 : 3 : 3 : 1, the one plant in 16 being a new type of the formula:
8. XX ZZ yy nn which Shull calls "subchlorina." Unfortunately he was unable to distinguish the "subchlorina" plants from the others. The number of green and pale leaved plants agreed very well with the expected ratio of 9 : 7, however.

Baur (6) says that a factor Z is necessary for the production of chlorophyll. Plants which do not possess it are pure white and cannot live. Factor Y is only active in the presence of Z. Plants with Z but not Y are yellow and cannot live. Factors Z and Y without N produce the pale green "chlorina" color. Factor N produces a green plant in the presence

PROBABLY A CASE OF INFECTIOUS CHLOROSIS

One of the causes of variegated leaves in plants is infectious chlorosis, a disease which is not inherited, but transmitted only by grafting. The leaf of *Farfugium grande*, here shown natural size, appears to be thus infected. The spots start from the small capillary veins and enlarge radially. "The white spots are surrounded by a border of yellowish green where the chloroplasts are losing their color," Dr. Chapin notes. "One gets the impression that the green cells are being bleached by a poison which diffuses slowly from centers scattered about the leaf, and it is hard to account for this except by the parasitic theory." (Fig. 13.)

of at least one Z and two Ys. The formula ZZ Yy NN gives "aurea" plants.

It should be borne in mind that the Z, Y and N factors in Melandrium are not necessarily the same as those in other plants, such as Antirrhinum. Baur and Correns seem to think that the inheritance of chlorophyll color is connected directly with the inheritance of the yellow pigment, carotin. Shull, however, on the basis of his work with Melandrium, believes that they are due to independent factors.

ATYPICAL MENDELIAN TYPES.

In the "variegata" form of *Mirabilis jalapa*, Correns (10, 12) shows a very puzzling type of heredity. This race of Four O'Clocks differs from the "chlorina" type in having patches of pure green scattered over a background of "chlorina" color on the leaves. The number and size of these spots varies greatly in different plants and fluctuates to some extent from leaf to leaf. Some "variegata" plants are scarcely to be distinguished from "chlorina," the green

spots are so few and small; while on others dark green spots are large and numerous. They have about 40% of chlorophyll as compared with 30% in "chlorina" plants.

Here and there on "variegata" plants one finds green branches which remain green without producing variegated leaves. Such branches are more common on heavily spotted plants, but they may occur on any though some may not happen to produce them. Branches with pure "chlorina" colored leaves might be expected, but they are not mentioned and apparently do not occur. "Variegata" plants are not true to seed. The variegated branches produce

1. "Variegata" plants between 90 and 100%.

2. Green heterozygotes, a few, whose offspring are green and "variegata" plants in the ratio of 3 : 1.

3. Green homozygotes, a few, with only green offspring. The green branches on "variegata" plants behave as heterozygotes producing green and "variegata" seedlings in the ratio of 3 : 1. "Variegata" is recessive to green and dominant to "chlorina," the F_2 generation segregating in each case in the usual 3 : 1 ratio. Correns gives the following Mendelian interpretation:

Green (G) is dominant over "variegata" (V) and both are dominant over "chlorina" (C). The genetic character of the germ cells in these plants would then be:

Green, GVC, GVc, GvC or Gvc.
"Variegata" gVC or gVc.
"Chlorina," gvC.

He reports the results of a few crosses between green plants whose germ cells had the constitution (GvC) and "variegata" (gVC). The F_1 plants were all green (GgVvCC). The F_2 plants had germ cells GVC, GvC, gVC and gvC in equal numbers, which gave green, "variegata" and "chlorina" seedlings in the ratio 12 : 3 : 1. A Punnett square may make this clearer to those who are unfamiliar with Mendelian ratios. In this square the male germ cells are placed above the diagram and the female cells along the left side. The nature of the plant formed by the union of any two cells is shown in the small square where the columns intersect.

MALES

FEMALES	GVC	GvC	gVC	gvC
GVC	GGVVCC Green	GGVvCC Green	GgVVCC Green	GgVvCC Green
GvC	GGVvCC Green	GGvvCC Green	GgVvCC Green	GgvvCC Green
gVC	GgVVCC Green	GgVvCC Green	ggVVCC "Variegata"	ggVvCC "Variegata"
gvC	GgVvCC Green	GgvvCC Green	ggVvCC "Variegata"	ggvvCC "Chlorina"

In this experiment Correns obtained 106 green plants in the F_1 generation. Ten of these, self fertilized, gave in the F_2 generation 360 green, 76 "variegata" and 28 "chlorina" plants, which agrees well with the theoretical expectation of 348 green, 87 "variegata" and 29 "chlorina."

The formation of green branches and the fact that the variegated branches are not true to seed is the difficult thing to understand about these plants. Correns suggests that they are really in a continual state of change from the homozygotic, "variegata" condition to the heterozygotic, green condition, but this hardly explains anything. It is simply stating the facts in another way. And it may be questioned whether a "variegata" plant which is constantly

SPOTTED VARIEGATION IN A BEGONIA

Not a chimera, but a plant probably suffering from infectious chlorosis. Its offspring, if produced by seed, will be normal; while if it were a periclinal chimera, as it appears at first sight, its parti-colored condition would be inherited. The spots on the leaves here start from time to time at a distance from the large veins and spread until they fuse together. The nature of the disease is not yet altogether clear to scientists. (Fig. 14.)

producing a small percentage of green plants should be considered a homozygote in the strict sense of the word.

Baur's (8) "variegata" type of snapdragon differs from this in the fact that it is true to seed, no green plants being produced. Normal green is dominant to this type of "variegata" and both are dominant to "chlorina." The F_2 generation splits in each case in the common 3 : 1 ratio. Baur's explanation is briefly this:

1. A factor, A, makes the green spots of "variegata" possible even in the absence of a second factor B.

2. A factor, B, makes a uniform green color possible even in the absence of factor A.

Then aaBB are green plants true to seed.

AAbb are "variegata" plants true to seed.

aabb are "chlorina" plants true to seed.

This theory agrees with the facts except for the cross between green and "variegata" in which the F_1 plants would be AaBb. They should then form germ cells with the factors AB, Ab, aB and ab in equal numbers and

VARIEGATED GERANIUM LEAVES

The group at the left is from a seedling whose father was a periclinal chimera with white edged leaves and whose mother was a green-leaved plant. The three leaves in the center are from three different periclinal chimeras. The two leaves at the right show a reversal of the usual condition in periclinal chimeras of the geranium. Here the green tissue is on the outside and the white inside. (Fig. 15.)

the F_2 seedlings would then be green, "variegata" and "chlorina" in the ratio 12 : 3 : 1 instead of the actual ratio of 3 green to 1 "variegata." To account for this Baur assumes that factor coupling occurs so that instead of all four types of germ cells being formed, the F_1 plants produce only two having the formulas Ab and aB. Just why Baur did not make use of Correns' factors G, V, and C which would seem to answer the purpose equally well without the assumption of factor coupling is not exactly clear.

NON-MENDELIAN TYPES.

Instances of heredity which are to be explained without the use of Mendelian formulas are so rare that the following types of inheritance possess an unusual interest.

The "albomaculata" type has been described by Correns (11) for Four O'Clocks, and by Baur (7) for Snapdragons. The plants have variegated leaves irregularly spotted green and white. Some leaves are nearly white with the green spots few and small while others are nearly green with little white. All graduations of color exist between these. There are also branches with pure white or pure green leaves which do not become variegated afterwards. Anatomically it is seen that the chloroplasts are bleached out more or less in the white areas and the change from green to white spots is a gradual one. Chloroplasts may even be unequally bleached in the same cell.

The green branches produce green offspring which are true to seed. White branches yield only white seedlings which soon die. Variegated branches produce, in addition to these, "albomaculata" plants which live or die according to whether they have or have not sufficient chlorophyll to sustain life. The ratio of green, white and variegated offspring from variegated branches is different in different plants, but still it seems to bear a direct relation to the amount of green and white in the leaves.

The pollen from "albomaculata" plants behaves in crosses as if it came from normal green ones. For instance the pollen from a blossom on a white branch of an "albomaculata" plant was used on castrated flowers of a "chlorina" plant. The F_1 plants were all green with green and "chlorina" seedlings in the ratio of 3 : 1. No "albomaculata" plants appeared. Likewise no segrega-

A VARIEGATED COLLECTION

(a) Abutilon, a periclinal chimera whose green leaves have white edges. In the upper leaves the envelopment of the green by the white tissue is not complete. The misshapen leaves show that the outside skin of white tissue exerts a restraining influence on the growth of the normal and more vigorous green tissue. (b) and (c) show other abutilon leaves, spotted but probably as the result of infectious chlorosis because they are certainly not chimeras. (d) is the Wandering Jew (*Tradescantia fluminensis*), a good example of sectorial chimera. It is remarkable for the fact that the guard cells of the stomata—the breathing pores of the leaf—always contain green granules of chlorophyll even if situated over white tissue, or on pure white leaves. This is not the case in the variegated pigweed or geraniums. (e) Leaf of the Small Mallow (*Malva rotundifolia*), a common weed. The light areas are pale green, not white. Some leaves on the plant are wholly dark green while others are wholly light green. It appears to be a sectorial chimera formed partly of pale green "chlorina"-like tissue and partly of normal dark green tissue. Heredity undetermined. (Fig. 16.)

tion in the F_2 generation occurs when the pollen of "albomaculata" plants is used on the blossoms of green plants, both the F_1 and the F_2 plants being green. On the other hand, when the pollen of green plants is used on "albomaculata" blossoms the result is exactly the same as if the flowers had been self fertilized.

Correns' theory is that the "albomaculata" character is due to a disease of the cytoplasm which does not affect the nucleus. The nuclei in these plants are supposed to carry factors necessary for chlorophyll formation like those of normal green plants. No cytoplasm, however, is carried into the egg cell by the male gamete, but only nuclear materal. So the condition can only be transmitted by the mother plant and apparently the female cells of the "albomaculata" plants may be affected to a variable extent, or not at all, which accounts for all the facts.

SECTORIAL CHIMERAS.

Our knowledge of the heredity of white and green leaved chimeras rests largely on Baur's (4) work with geraniums. Such plants with grayish green leaves with white edges are familiar to every one while the reverse type whose leaves have white or pale green centers and green edges is only a little less common. In these plants, as has been said, the embryonic tissue in th

apical cone is made up of two sorts of cells, one of which produces green tissue and the other only white. In the sectorial chimeras pure green or pure white branches are frequently formed from buds starting in green or white tissue. Periclinal branches arise from the overgrowth of one tissue about the other.

The heredity of these plants involves two difficulties:

1. Why the union of green and white germ cells does not produce Mendelian heterozygotes.
2. Why such a cross should sometimes produce variegated chimeras and at other times give rise to green or white plants.

Baur's answer to the first question rests on the fact that the chloroplasts have a heredity independent of the cells in which they live. Chloroplasts originate from the division of other chloroplasts and in no other way. This does not mean that mature chloroplasts are to be found in embryonic or sexual cells, but only that small bodies which develop into chloroplasts are there and that these small mother chloroplasts are not produced from the cytoplasm or chromatin, as was formerly thought.[1]

In the previous cases of abnormal chlorophyll development which we have studied we must suppose that the normal production of green leaves is prevented by the absence of useful factors or, in the case of the "albomaculata" plants, by the presence of inhibiting agents, acting on the chloroplasts. In the white tissue of the chimeras, however, the chloroplasts themselves are abnormal and will not properly develop. The union of white and green gametes results, then, in a zygote which contains at least one white and one green mother chloroplast. These divide into daughter chloroplasts which are distributed among the dividing cells at random. Baur assumes that cell division at first takes place more rapidly than chloroplast division so that eventually at an early stage in the growth of the embryo all the chloroplasts in each cell will be descended from a single mother chloroplast, white or green.

The second difficulty Baur answers by saying that the white and the green seedlings are probably extreme types of chimeras in which the apparently missing green or white tissue is represented by only a few cells which escape notice with the naked eye. He says he has been able to find small islands of white or green cells in seemingly pure green or pure white seedlings, though whether they are present in all cases he is, of course, unable to say.

According to this theory we would expect that the extreme types, the all green and the all white seedlings, would be rather scarce as compared with the variegated plants, instead of the heavy majority of green seedlings which Baur's figures show. In my own crosses variegated plants have always been in the minority, though in one case the white plants outnumbered the green. This is doubtless due to some unknown factors in the mechanism of development.

A good start has been made in the study of chlorophyll inheritance, but much remains to be done. Several of the theories given rest on the shaky foundation of few observations and small numbers. A discovery is hardly a discovery until others have repeated the work with the same results. The great importance of this work is seen when we remember that the welfare of all the higher forms of life depends ultimately on the work of the chloroplasts.

SUMMARY.

A pigweed, *Amaranthus retroflexus*, was found having variegated leaves. The plant was evidently a sectorial chimera composed of green and white tissue. Its offspring consisted of green, white and a few variegated seedlings like the mother plant. Green seedlings

[1] Ernst A. Bessey writes me: "The probability that the pollen carries over any *anlage* for chloroplasts is very slim, as it is only the two male nuclei from the pollen tube that seem to be essential, and only one of them enters the egg. These nuclei slip out of the cytoplasmic sheath way up in the style so that they simply enter into the fertilization as naked nuclei and not as in the lower plants, as whole cells. In some plants chloroplasts have been observed in the egg cell and in most plants where it has been investigated the *anlage* of such chloroplasts are present."

and green branches from variegated plants produced only green offspring. White branches produced only white offspring when self fertilized. Cross fertilization was not attempted. It is likely that the variegated plants which do appear come from a cross between green and white gametes. Probably the heredity of this plant belongs to the type of variegated chimeras of *Pelargonium zonale* described by Baur (4).

In conclusion I wish to express my thanks to Dr. Ernst A. Bessey and Prof. Henri Hus for their helpful encouragement and many valuable suggestions.

REFERENCES.

BAUR, ERWIN.

1. Zur Aetiologie der infektiösen Panachierung. Ber. d. Deutsch. Bot. Ges. 22, 1904, p. 453.
2. Uber infektiöse Chlorosen bei Ligustrum, Laburnum, Fraxinus, Sorbus und Ptelea. Ber d. Deutsch. Bot. Ges. 25, 1907, p. 410.
3. Untersuchungen über die Erblichkeitsverhältnisse einer nur in Bastardform lebensfähigen Sippe von *Antirrhinum majus*. Ber. d. Deutsch. Bot. Ges. 25, 1907, p. 442.
4. Das Wesen und die Erblichkeitsverhältnisse der "Varietates albomarginatae hort." von *Pelargonium zonale*. Zeitschr. f. ind. Abstamm. und Vererb. 1, 1909, p. 330.
5. Vererbungs- und Bastardierungsversuche mit Antirrhinum. Zeitschr. f. ind. Abstamm. und Vererb. 3, 1910, p. 34.
6. Untersuchungen über die Vererbung von Chromatophorenmerkmalen bei Melandrium, Antirrhinum und Aquilegia. Zeitschr. f. ind. Abstamm. u. Vererb. 4, 1910, p. 81.
7. Einführung in die experimentelle Vererbungslehre. Berlin, 1911.
8. Vererbungs- und Bastardierungsversuche mit Antirrhinum. II. Faktorenkoppelung. Zeitschr. f. ind. Abstamm. u. Vererb. 6, 1912, p. 201.

CORRENS, CARL E.

9. Über Bastardierungsversuche mit Mirabilis-Sippen. Ber. d. Deutsch. Bot. Gesell. 20, 1902, p. 594.
10. Vererbungsversuche mit blass-(gelb) grünen und buntblätterigen Sippen bei *Mirabilis jalapa*, *Urtica pilulifera* u. *Lunaria annua*. Zeitschr. f. ind. Abstamm. u. Vererb. 1, 1909, p. 291.
11. Zur kenntnis der Rolle von Kern und Plasma bei der Vererbung. Zeitschr. f. ind. Abstamm. u. Vererb. 2, 1909, p. 331.
12. Der Übergang aus dem homozygotischen in einen heterozygotischen Zustand im selben Individuum bei buntblätterigen und gestreift blühenden Mirabilis-Sippen. Ber. d. Deutsch. Bot. Ges. 28, 1910, p. 418.

MOLISCH, H.

13. Über die Panachüre des Kohls. Ber. d. Deutsch. Bot. Ges. 19, 1901, p. 33.

NILSSON-EHLE, H.

14. Einige Beobachtungen über erbliche Variationen der Chlorophylleigenschaft bei den Getreidearten. Zeitschr. f. ind. Abstamm. u. Vererb. 9, 1913, p. 289.

PRICE, H. L. AND DRINKARD, A. W. JR.

15. Inheritance in Tomato Hybrids. Virginia Agr. Exp. Sta. Bull. No. 177, 1908.

SHULL, GEO. H.

16. Über die Vererbung der Blattfarbe bei Melandrium. Ber. d. Deutsch. Bot. Ges. 31, 1913, p. 40. Generalversammlungsheft.

Eugenics and Genius

If anyone could devise for us a means by which the genius, potentially existing at any time, were realized, he would have performed in effect a service equivalent to that of which eugenics repudiates the present possibility—the actual creation of genius. * * * But if eugenics can raise the average level of human intelligence, in so doing not merely does it render more likely, as Mr. Galton points out, the production of men of the highest ability, but it provides those conditions in which men of genius, now swamped, can swim. We could not undertake to produce a Shakespeare, but we might reasonably hope to produce a generation which would not destroy its Shakespeares. And even if men of genius still found it necessary, as men of genius have found it necessary, to "play to the gallery," they would play, as Mr. Galton says of the demagogue in a eugenic age, "to a more sensible gallery than at present."—C. W. Saleeby: Parenthood and Race Culture (1909).

STUDIES IN HUMAN HEREDITY

Many Investigations Under Way in United States, Some of Them on a Very Large Scale—What the Investigators Are Doing—Help Wanted from Members of This Association.

DR. FREDERICK ADAMS WOODS DR. ADOLF MEYER
CHARLES B. DAVENPORT

Eugenics Research Committee of the American Genetic Association.

THE amount of research in human genetics and eugenics, now being carried on in the United States, is probably realized by few persons. In the following report, the Eugenics Research Committee of this Association has brought together data about some of these lines of investigation. The report does not include all such lines, or even all the important ones. It is probable that many investigators unknown to this committee are pursuing researches in different parts of the country; the committee hopes they will send to the JOURNAL OF HEREDITY brief statements of their work, in order that all those interested may know just what is being done, and what remains to be undertaken.

The object of the committee in presenting this report is twofold. In the first place, it is felt to be a matter of interest to genetists, both here and abroad, to know just what is being attempted in this branch of the science in the United States. In the second place, it is hoped that members of this association who know where valuable material may be found bearing on human heredity, but can not make use of it themselves and do not know to whom they may refer it, will be able with the help of this report to communicate with some one engaged on a similar line of research, letting him know where new material of interest to him can be obtained. If all who know of family histories including striking cases of the inheritance of twinning, left-handedness, feeblemindedness, congenital deafness, longevity, or a dozen other easily recognized traits, will communicate the fact to some worker in that field, it will immediately bring to light many new and valuable pedigrees which under present conditions are likely to remain buried for a long time.

The following report does not, for the most part, take into account investigations that have been made at some time in the past, and completed or given up before completion. It also omits many individuals who have conducted research work in the past, but are believed not to be actively engaged in such work at present. Workers are mentioned mainly in alphabetical order.

THE HYDE GENEALOGY.

Alexander Graham Bell, whose investigation of the inheritance of congenital deafness was the first serious study in cacogenics made in America, has just completed an exhaustive analysis of data contained in published genealogies of the Hyde family, with a view to discovering the degree of inheritance of longevity. His material embraces nearly 3,000 individuals, and the results leave no doubt that long life is largely dependent on heredity. When published, this investigation will also be an important contribution to the question of the results of early marriage, since Dr. Bell's statistics appear to show[1]

[1] C. L. Redfield's investigation seems to throw additional light on this point. From a study of 1109 cases he reports that the infant mortality is greatest among the children of old parents, but that if only children who reach maturity are counted, the longevity is proportional to the age of parents, the longest-lived children being those born when their parents were far past youth. "Taking the tables for longevity and infant mortality together, it will be seen that the children of young parents are more likely to survive to maturity than the children of old parents, but of those which do survive, the children of old parents live longer than those of young parents." (Dynamic Evolution, 1914, p. 185).

that the younger the parents at birth of an individual, the greater that individual's chance of long life. This correlation extends almost to the physiological limit at which reproduction becomes possible.

In order to continue the investigation of inheritance of longevity, Dr. Bell has founded the Genealogical Record Office, at 1601 Thirty-fifth street, northwest, Washington, D. C., where large numbers of genealogies are being gathered which include cases of long life in several generations; as rapidly as these accumulate in sufficient quantity, they will be subjected to analysis.

In addition to this strictly eugenic investigation, Dr. Bell is continuing his cacogenic researches, by analyzing in graphical form the data contained in Fay's "Marriages of the Deaf." The results leave no room for doubt that the most frequent cause of congenital deafness is heredity, and that if the congenitally deaf are allowed to intermarry, there is danger, as Dr. Bell pointed out more than a generation ago, of the formation of a deaf variety of the human race in the United States. The figures do not, however, bear out the statement often made by those who have not investigated the subject personally, that marriages between congenitally deaf persons invariably result in the production of deaf offspring.

The Volta Bureau of Washington, D. C., of which Dr. Bell is the founder, has on hand and is constantly adding to the largest collection of data in the world in regard to the inheritance of deafness. This includes the results of two special censuses made by the United States government, and has never been properly analyzed. Any investigator wishing to undertake a piece of statistical work on heredity of the highest practical importance could probably secure access to this immense collection of data, and would find that it yielded a maximum return from a minimum amount of work.

HARE-LIP PUZZLING.

William F. Blades of the Eugenics Record Office, Cold Spring Harbor, Long Island, is making a special study of hare-lip in man, and in addition to the collection of human pedigrees, is carrying on breeding experiments with several hare-lip strains of Boston Terriers. In the dogs as in man, hare-lip and cleft-palate are found to be highly hereditary in character, but up to the present Mr. Blades has been unable to determine in what way they are inherited, the material on hand, although it is considerable in amount, seeming to be insufficient to reveal the existence of any law. The investigation is complicated by the fact that many people endeavor to conceal slight cases of hare-lip, particularly if these have been partly or wholly remedied by surgical operation. Mr. Blades welcomes inquiries concerning this condition and provides blanks for the recording of family data to anyone interested in the problem and willing to furnish any information, be it even the names and addresses of individuals who may be able to provide material at first or second hand.

Professor J. McKeen Cattell of Columbia University, New York City, has been engaged for some years on a study of the families of 1,000 American men of science. The data, which are being analyzed from many points of view, are not yet wholly ready for publication. The birth rate is the central point of the investigation; it is decidedly low among this portion of the population, and evidence indicates that this is largely due to psychological, rather than physiological, reasons. Much of Professor Cattell's work has been the detection and elimination of statistical fallacies, in which this subject particularly abounds. Even such mathematicians as Francis Galton and Karl Pearson have run into pitfalls in dealing with it; it is, then, only to be expected that investigators of lesser note should often have gone astray, and that result is found to exist in nearly all the published work.

Following is a synopsis of his work on this subject:

"The completed family of contemporary scientific men is about 2, the surviving family about 1.8, and the number of surviving children from

each scientific man about 1.6. Twenty-two per cent. of the families are childless; only one family in 75 is larger than six. The same conditions obtain for other college graduates. Answers have been received from 461 leading scientific men giving the causes which led to the limitation in the size of their families. One hundred and seventy-six were not voluntarily limited, while 285 were so limited, the cause of the voluntary limitation being health in 133 cases, expense in 98 cases and various other reasons in 54 cases. Childlessness was involuntary in two-thirds of the cases. In the standardized family of two the condition is desired in six cases out of seven. In over one-third of the families the limitation was involuntary, due to infertility and other pathological causes, but if these had not obtained, voluntary limitation would have occurred in nearly all or perhaps in all cases."

ALCOHOL AND HEREDITY.

Dr. T. D. Crothers, Director of the Walnut Hospital for Inebriates, Hartford, Connecticut, is undertaking modern field studies among the families of inebriates.

Dr. C. H. Danforth and his associates of the department of anatomy, Washington University, St. Louis, Mo., have recently undertaken the investigation of a number of lines of heredity, in which anatomy plays a part. One of the methods of operation is to examine all subjects brought to the dissecting table, for abnormalities that give promise of being due to heredity. When such are found, living relatives of the deceased are sought out, and the pedigree made up as far as possible. The problem of twinning is also being attacked, but the results so far agree with those found by other investigators, in that they show some forms, at least, of twinning to be distinctly hereditary, without giving any clear light as to the manner in which the tendency is inherited. It is found that the measure of resemblance between twins is not a safe indication whether they are homologous ("duplicate," i.e., formed by a division of the fertilized ovum at the stage when it consists of two cells) or heterologous (ordinary twins). It is possible that the two types of twinning are differently inherited.

Charles B. Davenport, director of the Department of Experimental Evolution, Carnegie Institution of Washington, at Cold Spring Harbor, Long Island, New York, and also director of the Eugenics Record Office there, has been devoting particular attention during the last few years to the inheritance of mental traits. Many of these researches will be described in his forthcoming book, "The Feebly Inhibited," which will contain, among other first-hand field data, 165 family histories. It is a study of the nature and control of emotional impulses, with special reference to criminalistic traits, the manner of their inheritance, and their periodicity.

Under Dr. Davenport's immediate supervision, a special study in the inheritance of stature is being made by the Eugenics Record Office. The usual field studies in this office continue: at present they include a study of families that have produced many of America's most effective men, with special reference to the origin of their distinctive traits; and a further study of the Jukes family, that famous cacogenic group in the state of New York, which Dugdale brought to light 40 years ago. A. H. Estabrook, who unearthed the history of the "Nam" family, a somewhat similar group, a few years ago, has taken up the present status of the Jukes, in order to observe the changes that have taken place in them as they have become scattered over the country during recent years. It is interesting to find that a few branches which are far from the original environment have produced excellent and prosperous citizens—possibly as the result of some fortunate marriage in the previous generation. On the whole, however, this great tribe continues to furnish an almost unparalleled record of continuous inefficiency, from a social point of view.

CONSANGUINEOUS MARRIAGE.

The study of consanguineous marriages and their consequences, as observed

on the Maine coast, has been undertaken for the Record Office by Miss Mary M. Sturges, who previously investigated the same subject in isolated parts of Long Island. As the families dealt with are characterized by various defects, it is found, as was expected, that these are manifested in an intensified form, as the result of cousin-marriages, although it is generally agreed that such matings are quite proper if made in an untainted stock.

The study of the inheritance of Huntington's chorea is being carried on by Dr. Elizabeth B. Muncey, who has traced this condition, which behaves as a definitely dominant trait, back as far as the witches of Salem, at least one of whom in the strain it seems justifiable to chart as choreic. Family histories are being collected by field workers in 10 or 12 institutions for the feeble-minded, the insane, the epileptic, the alcoholic, the delinquent, etc. The documents thus collected, and also the contents of some printed genealogical and historical works, are being indexed by name, place and trait, in the Eugenics Record Office, and are accessible to serious investigators at any time. Schedules for a record of family traits are also distributed to all who will undertake to fill them out and return to the Record Office for permanent custody; in cases where it is requested, a duplicate schedule is sent to be retained by the person interested. Members of this Association are urged to assist in the collection of data by sending for and filling out such schedules. The Record Office also distributes, upon request by persons who are contemplating marriage, special schedules upon which they may record their family traits and which they may submit to the Record Office for comments with reference to the expectation of the traits of the offspring.

The Fifth Annual Training Class for Field Workers was held at the Record Office from July 1 to August 12 this year. It has been found that about one-half of the members of these training classes become field workers in some branch of the investigation of heredity in man. Usually the class numbers from 20 to 35 each year.

Dr. H. H. Goddard and his associates at the Training School (Vineland, N. J.) are now devoting all their time to working up material already on hand; the institution has no field workers out at present, since the amount of data awaiting analysis is already larger than can be handled. Dr. Goddard has just published a book (Feeble-mindedness, its Causes and Consequences) which gives the result of a study of the family history of 327 inmates of the Training School, in such full form as to furnish data for any future investigators who may differ from Dr. Goddard's conclusions.

FEEBLE-MINDEDNESS.

It is found that heredity alone explains about two-thirds of the cases of feeble-mindedness; the other third are due to such causes as accident, or sickness during childhood. This last cause is one which demands, and is now receiving, further study. Of a dozen children who have scarlet fever, for instance, 11 recover unscathed; the twelfth remains feeble-minded for life. The question at once arises, why was the one singled out in this way? and the apparent conclusion is again, heredity. It is found that the family histories of such children nearly always show weaknesses, which are absent from a normal pedigree. In connection with the family history of each inmate of the Training School, his or her mental and physical condition are carefully investigated, and studies also made on the metabolism, a biochemist and several assistants being kept busy on this work. It is found that feeble-mindedness (or at least, the lower grades of it) is not merely a mental defect, but that it indicates that the patient's physical condition is abnormal, as well. Extended research on this line may lead to the establishment of physiological tests to supplement the psychological ones now used to classify feeble-minded patients.

Among the family histories on hand at the Training School and awaiting publication is one embracing the group in northern New Jersey well known

under the name of "the Jackson Whites," and formed by an amalgamation of the white race with the negro and the American Indian, early in the last century. Detailed analysis of this unusual racial mixture will certainly prove of great interest to genetists; but one fact which already stands out prominently seems to be the very limited effect of environment, in influencing this mixed heredity. The socially degenerate group has spread to many points in the East, including cities and small towns; but wherever its members appear, they carry with them the "Jackson White" characteristics. It is clear, then, that their physical, mental and social condition can not be ascribed to any environmental factors, but that their deficiencies are to be explained, for the most part, by bad heredity.

In regard to the inheritance of feeble-mindedness, Dr. Goddard's data, above mentioned, convince him that it behaves as a Mendelian recessive.

MORTALITY STUDIES.

By far the most gigantic collection of data ever analyzed for the purpose which interests this Association is now being worked over in the Medico-Actuarial Mortality Investigation, which is directed by Arthur Hunter of the New York Life Insurance Company. Nearly all the prominent life insurance companies of North America are interested in this research, and have furnished details regarding 2,000,000 deaths, which are being investigated with a view to determining in what points the rates of the companies need revision. Much of the work falls outside the sphere of human heredity, but many facts have already been brought out which bear on the eugenics researches of the last decade. It is found, for instance, that the mortality is slightly *below* the average with people both of whose parents died of cancer. This, as Mr. Hunter explains, is doubtless because the policy-holders with such family histories represent a stringently selected class; the examining physicians would bar all but good risks, under those circumstances; and the result of this selection by the medical examiners is that those passed are particularly good risks, in spite of the fact that their parents died from the same malignant disease. The statistics with regard to consumption will be equally interesting: they have not been completed yet for the whole investigation, but the results of the New York Life Insurance Company are available, and probably represent the whole. It is found that in a young man or woman, a consumptive family history diminishes the expectation of longevity; but after the age of 40, the fact that an individual may have lost one member of the family through consumption has no effect whatever on the mortality. Four volumes of statistics from this investigation have already been published, and a fifth is to follow shortly.

An unusual amount of strictly eugenic research work is being carried on at the University of Pittsburgh, under the leadership of Professor Roswell H. Johnson, who offers a course entitled "Laboratory Work in Eugenics," which demands that every student entering it undertake some practical problem, usually in collaboration with the professor. Among the investigations of the past year are the following:

The inheritance of two peculiar traits in the human eye: very round eyes, and eyes closing in laughter. Both these traits, Professor Johnson says, show segregation, but apparently not on Mendelian proportions.

MARRIAGE AND BIRTH RATES.

A study has been made of alumni record books for marriage and birth rates of college graduates. This has particularly been the object of research among the graduates of women's colleges. Miss Bertha J. Stutzmann has been analyzing returns from some of the larger colleges, Miss Helen D. Murphey has tabulated the marriage and birth rates of Washington (Penn.) Seminary alumnae, and Miss Carrie F. Gilmore has been compiling facts about preferential mating in the graduates of a normal school.

A survey is also being made of the several wards of Pittsburgh, with reference to their vital and social statis-

tics, and they are being compared with wards in other American cities. Miss Sadie Scorer has been particularly engaged on the analysis of the racial contribution of these several wards.

Other problems on hand at this institution are the development of new psychometric tests for adults, a study of the geographical distribution of eminence in Europe, and a further analysis of Woods's distribution of eminence by names on a percentage basis. In all these investigations (except that with regard to the inheritance of traits in the eye which, having no social significance, is merely genetic) the viewpoint kept before the student at all times is that of actual race *betterment*, as distinct from a mere tabulation of genetic facts.

Dr. H. E. Jordan of the department of anatomy, University of Virginia, is working on the inheritance of twinning, and also of left-handedness. His data on the first subject give him ground for belief that twinning behaves as a Mendelian recessive. In regard to the inheritance of left-handedness, he said, in a recent lecture:

LEFT-HANDEDNESS.

"Left-handedness or right-handedness may be considered alternative or unit characters in a Mendelian sense. In terms of presence and absence, to which scheme the majority of Mendelian characters appears to conform, right-handedness may be conceived as dependent on the presence of the determiner in the germ-plasm, left-handedness and ambidexterity as the result of its absence. But right-handed individuals are of two sorts, those both of whose parents were right-handed, and those with only one parent right-handed. The former are said to be of duplex, the latter of simplex, condition. Those with both parents left-handed, i.e., lacking the determiner of right-handedness, are said to be nulliplex. The right-handed condition dominates or masks the left-handed condition in the hybrid generation. When left-handed mate with left-handed, all the children will be left-handed. When the determiner for a character is absent from the germ-plasm of the parent, that character can not appear in the body of the offspring. When simplex mate with simplex, one in every four will be left-handed. This is the well-known 1 to 3 Mendelian ratio for hybrid crosses with respect to a particular pair of unit characters. When simplex mate with nulliplex one-half of the offspring will lack the determiner for right-handedness and be left-handed."

Dr. Jordan further notes, "I have on hand also a considerable body of data relative to the inheritance of various types of thumb-prints, but up to the present I have not been able to make any very satisfactory interpretation of my material."

Miss Isabelle V. Kendig, late of the Monson State Hospital, Massachusetts, has recently finished an intensive study of one Massachusetts family belonging to the old American stock. The progenitor of the line left England in 1623, establishing himself at Plymouth; from there his descendants moved inland and finally settled among the hills of western Massachusetts. From that time they have begun to degenerate, and it was the object of the investigation to learn why. "There, in an isolated and unfavorable environment," Miss Kendig says, "they intermarried and multiplied, till today their blood has impregnated the entire community and rendered the town of B—— a byword for shiftlessness and poverty, for alcoholism, immorality and feeble-mindedness." The investigation well shows the danger to the commonwealth in the tendency for like mate with like, thus emphasizing and perpetuating bad characteristics which, in an environment that allowed more out-crossing, might disappear.

MARRIAGE SELECTION.

Dr. Wilhelmina E. Key of the State Institution for Feebleminded at Folk, Pennsylvania, has nearly completed the study of a Pennsylvania family of more than 1,800 individuals, about half of whom are in the direct line of descent from two pairs of German immigrants of over a century ago; the remainder were studied in connection with strains into which marriage occurred. Both networks break up into widely divergent

lines which vary greatly in social efficiency, and Dr. Key concludes: "Their evolution shows the effect of marriage selection in concentrating defect and degeneracy in certain lines, and dissipating defect and introducing traits which make for increased efficiency in others." Special attention was given to the appearance in successive generations of different grades of calculating-ability, aggressiveness and perseverance, and the investigator thinks that these traits appear in conformity with Mendel's Law.

Samuel C. Kohs of Clark University, Worcester, Mass., who approaches the problem of eugenics from the psychological side, writes as follows: "My work comes, first, under the broad head of the psychology of individual differences. More specifically, however, my interest is focussed on the significance of the complex, for differential psychology as well as for mental inheritance. My studies have led me to conclude that the unconscious should be given a more prominent place in psychogenesis. Most modern psychologists recognize that conscious phenomena are but a small fraction of all psychic functioning, and that most of the important factors influencing activity, mental and physical, lie below the conscious threshold. Some of these factors are reducible to the complex as at present used in psychoanalysis.

"As we come to recognize more and more the deep significance of Semon's mnemic theory, the more are we led to believe that inherent mental ability is not as simple a structure as has been assumed by many.

"A paper attempting to deal with this problem adequately would include the following:

"(1) Discussion of the complex and its significance.

"(2) Discussion of the unconscious in relation to the dynamic forces of life activity.

"(3) Methods of diagnosing the existence of complexes.

"(4) The complex and the question of unit characters."

H. H. Laughlin, superintendent of the Eugenics Record Office, has been devoting his attention particularly to a study of the effects of sterilization in reducing the amount of caogenic breeding in the United States. He writes:

"We hope at intervals of not too long a time to publish the reports outlined in Bulletin No. 10a. The American Institute of Criminal Law and Criminology, at its recent meeting, appointed Committee H on sterilization. This committee consists of:

"Joel D. Hunter, Chief Probation Officer of Cook County, Chicago, Ill.; Father O'Callaghan and Dr. William T. Belfield, of Chicago; Judge Warren W. Foster, of New York; Dr. William A. White, of the Government Hospital for the Insane, Washington; Hastings H. Hart, of the Russell Sage Foundation, New York; and H. H. Laughlin, of the Eugenics Record Office, Cold Spring Harbor, L. I."

RESEARCH IN BALTIMORE.

The Henry Phipps Psychiatric Clinic of Baltimore, directed by Dr. Adolf Meyer, is collecting data about the ancestries of its patients, and is also collecting similar data from school children in one ward of Baltimore. An analysis of the recorded matings and their offsprings is being made with special attention to a more definite characterization of common traits and their groupings in the diverging lines of the families and especially also the weight of ontogenetic factors in the determination of the individual fate and means of analyzing the personality.

Casper L. Redfield of Chicago has been studying for many years the effect of the age of parents on the character of the offspring, particularly from an intellectual point of view. This investigation, which has led not only to a thorough study of the parentage of men of genius, but to similar studies on race horses, cattle and pedigreed dogs, has led Mr. Redfield to a belief in the inheritance of certain classes of acquired characters, and the data which he has published probably form one of the most serious contributions made to Lamarckism during the last decade or two. The practical conclusion which he reaches is that intellectual excellence

in a child depends largely on the age of its parents at its birth. Mediocrities, he believes, are likely to be produced by very early marriages, unless the preceding generations married late enough to transmit qualities which will overcome the effect of the one early marriage. Men of genius, he finds, are usually produced by parents who are well advanced in years; and when data for previous generations exist, he usually finds that the grandparents and great-grandparents, as well, were mature when they made their contribution to the race.

Dr. A. J. Rosanoff, first assistant physician at Kings Park Hospital, New York, has been engaged on a study of the distribution of insanity in the United States, and the correlation of this distribution to other conditions in the country. The number of insane persons confined in institutions, per 100,000 of the general population, varies from 67.0 in Oklahoma to 413.4 in Massachusetts. These variations appear to the investigator to be in correlation, direct or reverse, with the following factors: per capita wealth production, percentage of urban population, general prevalence of illiteracy, accessibility of institutions, intra-mural conditions as reflected in the per capita cost of maintenance, and percentage of foreign-born population. Dr. Rosanoff is also working more intensively upon the inheritance of insanity, in particular families.

THE GATZERT FOUNDATION.

The case of feeble-mindedness, which hitherto has furnished the most widely worked field for the study of human heredity in the United States, is being attacked in a slightly different way by the Gatzert Foundation of the University of Washington (Seattle, Wash.). A clinic, directed by Dr. Stevenson Smith, examines several hundred children each year and obtains their family histories, whether they be precocious, average or defective. Field workers then fill in the gaps of this history, devoting particular attention to the pedigrees of children who are found to be defective but seem to show no pathological ancestry. This investigation should serve as an invaluable parallel and "control" to the many other investigations of feeble-mindedness, in which particular attention is paid to the pedigrees which show the presence of a taint in the ancestors.

Dr. David F. Weeks, superintendent of the New Jersey State Village for Epileptics at Skillman, N. J., reports:

"The aim of the work in eugenics research at the State Village has been, since it started in 1910, to obtain a hereditary history of every epileptic patient who came to the colony—not to work up special cases, but to work up all cases. From these histories we hope to learn the laws governing the inheritance of epilepsy.

"We now have filed 672 histories; these cover anywhere from two to eight generations and from 20 to three or four hundred individuals. Each case is analyzed as to the family traits observed, the types of matings from which our patients come, as well as the environmental conditions and diseases. The traits which occur most frequently in our histories are, besides the epileptic convulsion itself, extreme nervousness, migraine, alcoholism of the periodic spree type, and bad temper. In fact, nervous conditions which show periodic loss of control all stand out prominently in our histories. The epileptic convulsion seems to behave like a Mendelian trait of the recessive type. There does not seem to be any one particular type of mating.

"Besides the regular history work we try to keep in close touch with the epileptic 'situation' in the state. We keep a register and each month make a report on the number of epileptics in the state whose names are known to us, with the kind of care they are receiving.

"We also follow up discharged cases. By means of a name index we are able to connect and show relationship between many of our patients not known to be related. We hope to work up many special cases in detail in the future, but at the same time to continue the general line of research as outlined. One special history has been worked out covering over 1700 individuals.

"The Eugenics Research Department consists of two field workers and one stenographer."

GREAT PERSONALITIES.

Dr. Frederick Adams Woods of Brookline, Mass., states the scope of his present studies as follows:

"I am continuing my investigations in positive eugenics, the origin and influence of exceptional persons and superior stocks, utilizing the easily accessible records of history and genealogy.

"I have found that in Great Britain the material welfare of the nation during the last two centuries has been greatly dependent on the presence of a few very exceptional statesmen, chiefly prime ministers. At least, it may be said that there is a strong correlation between politico-economic conditions and the character of English political leaders and that under weak and incompetent premiers the country has been visited by relative stagnation or decline. It is already statistically known that the able statesmen, for which England is famous, have been born in the upper classes. Therefore, the greater their influences are proved to be, the greater is the importance of positive eugenics. These questions of the influences of great men over their times, and the comparison of great men with mediocre, are important ones, and have, as yet, been little investigated by suitable statistical devices Such historiometric researches as have already been made indicate that the gap is very wide between the average man and the man of genius.

"The scientific productivity of a country is one measure of its intellectual life, therefore it has been thought worth while to prepare an objective list of the most eminent names in the history of science, during all times from the age of the Greeks to the present day. Such a list, with the inferences to be drawn from it, will shortly be ready for publication.

"All belief in the value of eugenics hangs upon a belief in the value of heredity over environment. Hence any research which brings to the proof a failure on the part of modified surroundings to make good its claims to strength and merit, is a weapon in the hands of the eugenist. Among exposés of this sort may be mentioned the failure of American conditions of so-called equality to make success in America any less of a family affair than it is in the caste-ridden countries of Europe. In an article 'Heredity and the Hall of Fame,' published in *Popular Science Monthly*, May, 1913, the indication of this truth was given. The names in the Hall of Fame can be measured against the eminent Europeans, listed by Galton, de Candolle, Ellis, Whetham and others. Now it remains to extend the list of worthies downward from the Hall of Fame, to utilize our history and biography informing a satisfactory working list of reference and appeal, and to bring together our genealogical researches in a scientific manner.

"Some results will very shortly be ready for publication, based upon a tentative objective list of about 3,500 of the most eminent Americans, divided into several grades, showing occupations, birth-places by states, and the different degrees of relationship to others within the list. The latter ratios rise rapidly as they approach the 47 preëminent Americans who are in the Hall of Fame. The research as a whole strongly indicates the influence of heredity over environment."

Tables For Biometricians

Tables for Statisticians and Biometricians is the title of a new publication (pp. lxxxiv + 143), edited by Karl Pearson and published by the Cambridge University Press (1914) at the price of nine shillings. The book is made up of tables needed for reference by workers in the field of advanced statistics, most of which have already been printed in Biometrika. It is preceded by an extensive introduction, describing the particular purposes of the tables, and giving examples of the way in which they can be used in the solution of biological and other problems.

SKIN COLOR OF MULATTOES

Apparently Four Factors Involved—Segregation in Second Generation—Skin Pigment Developed After Birth—No Correlation Between Color of Skin and Curliness of Hair in Offspring of Mulatto Marriages.[1]

Charles B. Davenport

Director, Department of Experimental Evolution (Carnegie Institution of Washington), Cold Spring Harbor, Long Island, New York.

THE method of heredity in negro-white crosses has long been cited as a demonstration of the failure of modern principles of heredity in their application to some specific cases. Skin color is said to show a typical blending, as in the mulatto, and it is generally assumed that all of the offspring of two mulattoes resemble their parents in skin color; and if a mulatto be crossed with a white that all of the offspring will be of a shade still lighter than the mulatto parent, namely, of a quadroon color. The current theory also has a great social importance because according to it, "once a negro, always a negro;" since the negro characteristics can not be wholly eliminated even by successive matings with white. However, as a concession, certain States even in our South permit the offspring of a person containing one-eighth negro blood and a pure white to pass as a white citizen and to marry, legally, a white person. That is, after matings of a mulatto and her offspring for two further generations with white persons the final generation may pass for white.

In order to test the theory that hybridization of skin color really does show a typical blending and failure to segregate, the author, with the assistance of a trained field agent (Miss Florence Danielson), has made measurements upon the skin color of between 600 and 700 children derived from about 200 pairs of parents and also of various other relatives. These studies were made chiefly in the islands of Bermuda and Jamaica because it was believed that the investigation would meet in those islands with fewer social obstacles. Such social obstacles were, indeed, encountered but the result justified the selection of the localities. The measurement of the skin color was made by the aid of a color top in which the proportion of black, red, yellow and white factors upon a circular disk may be varied so that, when the top is spun, any desired combination of proportions of these colors may be secured. The result of this investigation is clear cut, namely, skin color does segregate and the offspring of two strict mulatto parents may have skin color ranging from that of a pure white to quite dark in color, like that of a West Coast African negro. Segregation certainly does take place.

FACTORS ARE COMPLICATED.

The study shows, moreover, that the apparent blending is due to the complicated nature of the factors upon which negro skin color depends. After careful analysis of all of the results of all of the varied matings that were studied, the conclusion was drawn that in the full-blooded negro there are four factors that make for skin pigmentation and that correspondingly there are five conditions of these factors possible in the skin of the descendants of mulattoes, namely, no factor for black, one factor, two factors, three factors, or four factors for black. It follows from the fact of segregation also that the offspring of two mulattoes are much more variable

[1] This study was published in 1913 by the Carnegie Institution as publication No. 188, "Heredity of Skin Color in Negro and White Crosses." The accompanying illustrations are reproduced from that monograph.

VARIATION IN MULATTO PROGENY

The family of a white man of colored ancestry, and a mulatto woman. All seven sons and daughters are shown in the photograph. The infant is the lightest, with 8% black in the skin; this will doubtless darken with age. The son at the extreme right of the picture has 22% black in his skin; the boy at the extreme left has 26% black. (Fig. 17.)

OFFSPRING OF WHITE X MULATTO MATING

Part of the "W" family, including a medium colored mother and six of her seven children by a white man; also a little first cousin of the other children, who is directly in front of the mother. Note the great variation in the facial coloration of full brothers and sisters. The skin color of the youngest child is the same as that of a typical white infant, namely, 5% black, whereas the oldest boy of the group has a skin color of 32% black, considerably darker than his mother. (Fig. 18.)

than mulatto parents themselves. Such proves, indeed, to be the fact. Now, the white offspring of two mulattoes when mated together would seem always to give only white children. Numerous stories that are current of the reappearance of full black-skinned negro children from two white parents one of whom is of remote negro origin we could not confirm. A few stories to this effect were, indeed, current in Bermuda but they all related to matings that were made long ago and of whom the principal parties had passed away. Unless further more precise evidence to the contrary is forthcoming the current folk lore of such recurrence of full blacks to whites may be relegated to the category of "old wives' tales." The very different grades of skin color in the offspring of mulattoes correspond to a popular nomenclature, also, and in addition to white we have the quadroon, the mulattoes, the samboes (or three-fourths black), and the full black. And if the proportion of black in the whole population be considered, it will be found that, in the descendants of mulattoes, these five points represent exceptionally common positions in the general frequency curve of skin color. One of the interesting facts brought out in the investigation was the fact that the negro skin-color undergoes a clear development from birth onward during the first two years or more of life. The negro child at birth has an extremely light-colored skin, somewhat more yellowish than that of a white child. But within a few hours after the child is exposed to the daylight color begins to form and most swiftly in those parts which are exposed to the sunlight, excepting that the perineal region of the infant is, at birth, quite highly pigmented. Eventually, however, about the same depth of pigmentation is achieved whether the child grows into a woman or a man. There seems to be no difference in the color of the mulatto children whether the dark parent be the father or the mother.

No correlation was found in these studies of the children of mulattoes between the color of the skin and the curliness of the hair; so that, indeed, white-skinned, kinky-haired children and black skinned, straight-haired children were not an uncommon occurrence.

Our studies, also, furnish no support for the view that hybrids are less fertile than pure races in man. Some of the most fecund families of Jamaica are those of mulattoes.

The Principles of Eugenics

Those who are seeking to retain the name "Eugenics" for that section of genetics which deals with man, are not likely to welcome the little book called "The Principles of Eugenics" by Blanche Eames, Assistant Principal of the Correspondence School of Gospel and Scientific Eugenics (Chicago), which has just been issued by Moffat, Yard and Company, New York (pp. 91, price 75 cents). The writer belongs to that school which sees in sex hygiene the principal factor of eugenics. "Heredity" is limited to one chapter of 12 pages, while the other chapters discuss Reproduction, Race Poisons, Instruction in Sex Truths, Tobacco and Drugs, Parental Nutrition and Environment (two chapters) and Continence. The author is a convinced, although not critical, disciple of Lamarck, and an equally convinced and uncritical believer in "prenatal culture," "maternal impressions" and similar phenomena which most geneticists consider little better than superstitions. The book is sub-titled "A Practical Treatise," but the practical measures of eugenic import which the author proposes seem principally to consist of negative eugenics through asexualization and positive eugenics through proper mental attitude of expectant mothers. The JOURNAL OF HEREDITY can hardly accept this as a working program for the science of eugenics. The author has useful ideas on the subject of racial poisons and sex hygiene, and it is a pity that she could not present them except under the name of eugenics.

MISSING TEETH INHERITED

Lateral Incisors and Third Molars or "Wisdom Teeth" Most Frequently Absent—Cause to be Sought in Evolution of Man and Change of His Habits of Eating—Loss of Importance of Canine Teeth.

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I HAVE made the acquaintance of an educated Piedmontese youth who shows the congenital absence of the upper lateral right incisor; he has informed me that his father, his two brothers and their two sisters, all older than he, present the same defect, as did an uncle, his father's only brother; and his paternal grandfather. In all of them, the absence of the tooth is accompanied by a noticeable reduction in size of the corresponding incisor on the left side.

Dental agenesia as a phenomenon of heredity has been noted by a number of observers in the past. Hereditary absence of the lateral incisors has been observed in two or three generations and the inheritance may be either direct or alternate. Magitot refers to a woman who showed a lack of the upper, lateral incisors, as did her daughter and nephew; and of a man who lacked the lateral upper right incisor, as did his daughter and his nephew; Leroy d'Etiolle describes the same sort of agenesia in a woman and her three sons.

Perrin has cited the case of a family in various members of which the two upper lateral incisors were lacking, and says the defect had existed in the family for many generations.

The phenomenon of congenital absence of teeth, like that of the augmentation of their number, is a form of meristic variation, according to Bateson's terminology, and usually appears as a form of discontinuous variation; it can not be considered in itself a fact of atavism, a phenomenon of reversion, but at the most a phenomenon of arrested development. I should note that Dependorf has recently also combated, to a certain extent, the explanation of atavism for supernumerary teeth, in which the idea of reversion is much more easily sustained than in agenesia, considering the phylogenetic evolution of the dental system from the lower to the higher vertebrates.

The congenital absence of incisors is in a way a teratological phenomenon, inasmuch as it appears unexpectedly in a given individual of the species, and no equivalent condition is found in the most closely related species; and it is particularly teratological in character if it is coupled with similar occurrences in the molar teeth. But at the same time, it is also a progressive phenomenon when it follows a law of evolution: so that the fact of lack of certain teeth can have different meanings according to the number or type of teeth wanting. It seems to me that the lack of the superior lateral incisors in man (or the presence of extra ones) indicates a new step in the so-called regressive evolution of the dental system, just as does the disappearance of the third molar (the *wisdom tooth.*)

EXPLANATION OF THE CONDITION.

Amadei in 1881 proposed the hypothesis that the same movement of evolution which tends to cause the disappearance of the last molar would make its action felt on the entire jaw, but particularly at its two centers of reduction: one corresponding to the location of the third molar and the other at the point where the lateral

[1]Translation and abridgment of "Mancanza congenita ed ereditaria di un incisivo," in Atti della Societá Romana di Antropologia, Vol. XV, p. 395, 1909.

incisor is located. This is the weak point because of orthognathism, and because of the tendency of the maxillary arch to become constantly more acute.

The phenomenon appears as a form of transition, in the subject which I examined, because one of the incisors is lacking and the other very slightly reduced in size, while the teeth between seem to attempt to compensate, by their notable increase in size, for the inadequate development of the laterals. To confirm this idea, it is sufficient to record an easily observed fact, and that is the frequency with which, in the skulls of civilized peoples, the upper medial incisors appear much enlarged and those beside them much reduced, a difference which is also observable in the skulls of prehistoric peoples. This morphological condition is an indication of the modified functional conditions to which man's teeth are subjected in comparison to those of the other vertebrates nearest to him in anatomy and relationship. The function of the incisors is essentially the seizing of food, and particularly the separation (*incidere*) of the part which is to be taken in the mouth, from that which remains in the hand; this function is preceded and then assisted to the highest degree by the canine teeth, which have to sieze and hold the prey during the time necessary for the *incisive* operation; the canines also have a special function as a weapon of offense and defense. In man this last function of the canines is abolished, while that of seizing is largely reduced in importance, particularly among civilized peoples; for these reasons the canines no longer project below the plane of the other teeth, and to that extent lose the characteristic pointed form which they have in other genera of vertebrates. When man eats, he first divides the food for chewing, principally by the use of his medial incisors and to a less extent with the lateral incisors; and particularly with those of the upper jaw, since it projects forward of the lower one. The food is then pushed into the mouth for mastication, and from then on the work of the lateral incisors and canines is very slight. The width to which man opens his mouth is small in comparison with its aperture, and in comparison with the habit of other vertebrates; this is because of his orthognathism or lack of "muzzle" and because of a diminution of his voracity, which leads him to introduce into his mouth only a small quantity of food at one time; these facts favor the action of the medial incisors and diminish the importance of the other incisors and the canines; the result is that the superior lateral incisors are now an organ subsidiary to the medials.

The Justification for Eugenics

Individuals appear to me as partial detachments from the infinite ocean of Being, and this world as the stage on which Evolution takes place, principally hitherto by means of Natural Selection, which achieves the good of the whole with scant regard to that of the individual.

Man is gifted with pity and other kindly feelings; he also has the power of preventing many kinds of suffering. I conceive it to fall well within his province to replace Natural Selection by other processes that are more merciful and not less effective.

This is precisely the aim of Eugenics. Its first object is to check the birth-rate of the Unfit, instead of allowing them to come into being, though doomed in large numbers to perish prematurely. The second object is the improvement of the race by furthering the productivity of the Fit by early marriages, and healthful rearing of their children. Natural Selection rests upon excessive production and wholesale destruction; Eugenics on bringing no more individuals into the world than can be properly cared for, and those only of the best stock.—Francis Galton: Conclusion to Memories of My Life (1908).

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